...ents - Page 49
...chnical Library

May, 1940

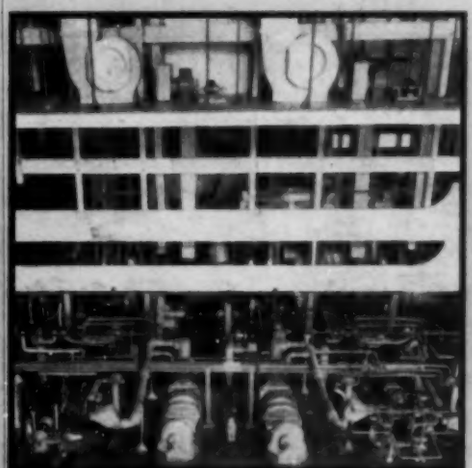
Heating · Piping and Air Conditioning

...n • Installation
...tion • Maintenance
...ercial, Industrial
...Large Buildings

MAY 6 1940

BOILERS IN TIGHT SPOT—and how they were put there to heat apartment buildings—is described on page 291

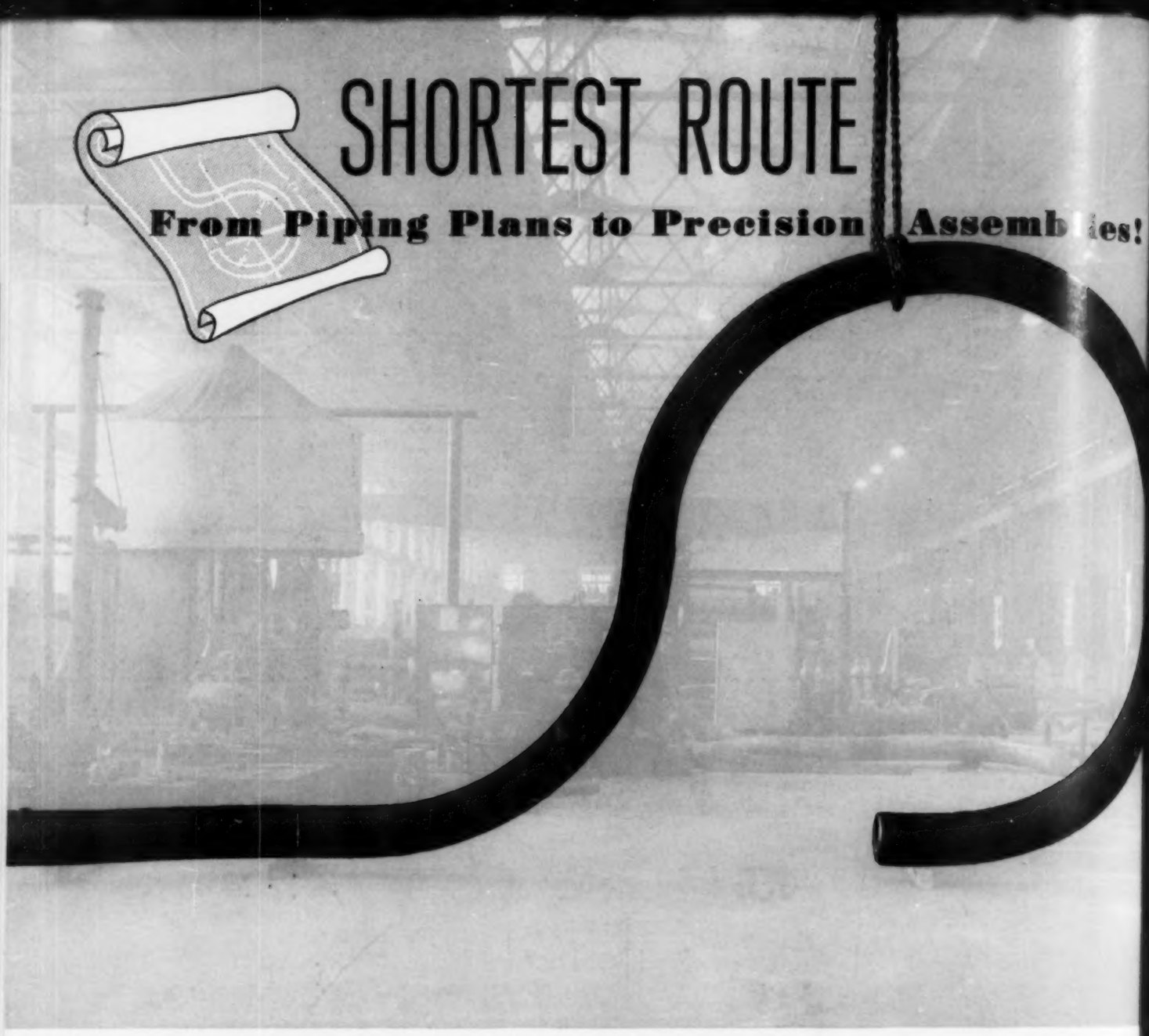
PANEL HEATING—and cooling—job is explained on page 281. This type of system receives much attention



PIPING DRAFTING is the subject of the article on page 285. This view shows a model of a turbine room basement

AIR CONDITIONING activity — reported on page 45—should be stimulated by World's Fair, re-opening in New York May 11

Page 315
...ournal Section
...he American
...y of Heating and
...lating Engineers



SHORTEST ROUTE

From Piping Plans to Precision Assemblies!

GRINNELL PREFABRICATION COMBINES INTERPRETIVE ENGINEERING AND ADVANCED SHOP FACILITIES

CONSIDER the difficulties that would be involved in *field construction* of the special piping illustrated! Forty-six feet of 12¾" x .843" Carbon Moly stock . . . engineered for specific power plant service . . . formed and welded into a continuous, accurate sub-assembly.

In this instance, engineers chose a modern shorter way . . . submitted plans to Grinnell. From precise interpretive engineering of the plans, to final underwriter's testing of completed sub-assemblies, Grinnell's advanced pre-fabricating facilities produced this and other units of the system by efficient, straight-line methods. Accurate sub-assemblies were delivered on schedule, ready to install with minimum field-welding.

You'll save time and grief on any special power or process piping system when you specify: "Give the plans to Grinnell"! Completely-equipped Grinnell plants are strategically located to serve you. Grinnell Co., Inc., Executive Offices, Providence, R. I. Branches in principal cities.

PREFABRICATION BY GRINNELL

WHENEVER PIPING IS INVOLVED

Heating · Piping and Air Conditioning

with which is merged the "Aerologist"

Design, Installation
Operation, Maintenance
in Industry and Large Buildings

◆ ◆ ◆

BOARD OF CONSULTING & CONTRIBUTING EDITORS

A. R. Acheson, A. Beaurrienne, Sabin Crocker, R. C. Doremus, Philip Drinker, E. L. Ellingwood, Walter L. Fleisher, William Goodman, John F. Hale, William A. Hanley, L. A. Harding, J. J. Harman, R. S. Hawley, E. P. Heckel, J. C. Hornung, John Howatt, Lee P. Hynes, Alfred Kellogg, C. W. Kimball, Dwight D. Kimball, Charles S. Leopold, Samuel R. Lewis, Homer R. Linn, A. W. Moulder, H. C. Murphy, Alfred J. Offner, F. B. Rowley, Robert P. Schoenijahn, T. S. Tenney, Rush D. Touton, W. H. Wilson

EDITOR — Chas. E. Price

ENGINEERING EDITOR — C. M. Burnam, Jr.

ADVERTISING STAFF

W. J. Osborn, R. Payne Wettstein, R. A. Jack
J. H. Tinkham

◆ ◆ ◆

Published monthly by the Keeney Publishing Company, 6 N. Michigan Ave., Chicago. Telephone: State 6916/ F. P. Keeney, President; W. J. Osborn, Vice-President; R. Payne Wettstein, Secretary; Chas. E. Price, Treasurer/ Address all correspondence to Chicago office/ New York office, Room 1734, Grand Central Terminal Bldg. Telephone: Murray Hill 9-8293/ Cleveland office, 2128 Rossmoor Road. Telephone: Yellowstone 1540/ Los Angeles office, 1406 S. Grand Ave. Telephone: Richmond 6191/ Subscriptions: U. S. and possessions, Canada, Mexico, Central America, South America, $2.00 per year; other, $4.00. Current copies, U. S. and possessions, 25c each, back copies 50c each. January, 1940, issue, $1.00 per copy/ Member of Audit Bureau of Circulations/ Member of The Associated Business Papers, Inc./

Copyright, 1940, by the Keeney Publishing Company

CONTENTS *for* MAY, 1940

Volume 12 — Number 5

Panel Warming and Cooling, by Erwin L. Weber 281

Dam Is Refrigerated, by Walter E. Becker 284

Types of Drawings Used in Power Piping Drafting, by Albert Jorgensen .. 285

The Air Conditioning Contractor, by John H. Carter 289

Getting Boilers Into a Tight Spot, by Edwin A. Kingsley and R. Stewart Bruns, Jr. 291

New York Air Conditioning Systems Must Have Water Saving Equipment 294

Air Conditioning Sold at Auction 294

How to Choose Economical Fuel for Heating Boilers, by Paul R. Unger .. 295

Steel Mill Cleans Air Electrically 297

Air Conditioning Serves New Industry, by A. T. Spangler and Fred Pederson 298

Corrosion in Steam Heating Systems—Feedwater Treating System in Central Heating Plant, by Leo F. Collins with Everette L. Henderson 299

New Features for World's Fair Air Conditioning Exhibit, by J. I. Lyle 302

The Psychrometric Chart—Its Theory and Application, by William Goodman 303

Old Cooling and Ventilating System Converted to Up-to-Date Air Conditioning, by Henry W. Moore 306

Unit Heater Over Revolving Door Solves Entrance Heating Problem, by John G. Eadie 307

Oxy-Acetylene Welding Procedure for High Pressure and Temperature Piping 308

Properties of Mixtures of Air and Saturated Water Vapor for Barometric Pressures from 22 In. to 32 In. of Mercury, by William Goodman 311

Determining Power Requirements for Refrigeration Compressors, by Richard J. Panlener 313

Booklets, Reports and Papers 314

Book Reviews 314

The Editor's Pages (front section) 45

Equipment Developments (back section) 114

Conventions and Expositions (back section) 134

Recent Trade Literature (back section) 136

Index to Advertisers (back section) 144

Journal Section of the American Society of Heating and Ventilating Engineers

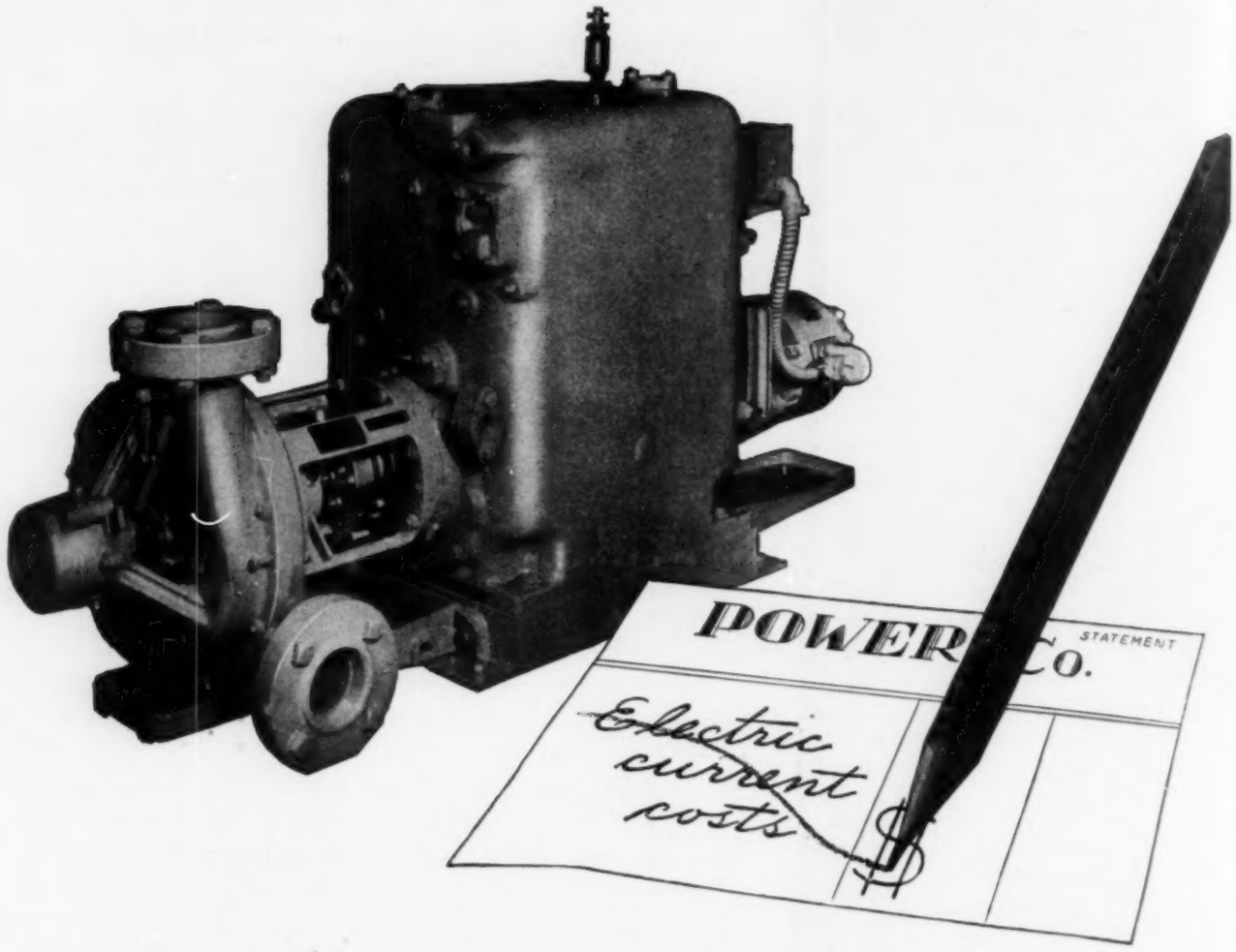
Reactions of 745 Clerks to Summer Air Conditioning, by W. J. McConnell and M. Spiegelman 317

Fever Therapy Locally Induced by Conditioned Air, by Murray D. Ferderber, F. C. Houghten and Carl Gutberlet 323

Dynamic and Thermal Behavior of Water Drops in Evaporative Cooling Processes, by H. B. Nottage and L. M. K. Boelter 326

Bulletin Section 333

A NASH VAPOR TURBINE HEATING PUMP WILL ELIMINATE THIS EXPENSE ITEM.



The Jennings Vapor Turbine Return Line Vacuum Heating Pump requires no electric current, eliminating the one biggest expense item in the operation of an ordinary return line pump. This is because the motive power is a special turbine operating on steam direct from the heating system. Steam used to drive the turbine is returned to the system for heating, with little heat loss.

The really important saving promoted by the Jennings Vapor Turbine is in the system itself, however, for this is the only heating pump that can operate continuously with economy. Continuous operation means uniform circulation, and uniform circulation means a big saving in steam.

This pump has but one moving part, no internal wearing parts, and no internal lubrication. It is compact and quiet, and will give long and satisfactory service at the lowest maintenance cost. Bulletin No. 246 tells all about it. It is free on request.

THE NASH ENGINEERING COMPANY

SOUTH NORWALK, CONNECTICUT, U. S. A.

THE EDITOR'S PAGES

FIRST QUARTER'S AIR CONDITIONING ACTIVITY SHOWS INCREASE OVER LAST YEAR

According to data on number and capacity of air conditioning installations during the first quarter of this year as compared with the first quarter of 1939, the industry is showing up very well in many cities although in some areas this year's jobs are about the same or somewhat under last year's. The figures were obtained through the courtesy of the electric utilities serving the various cities for which information is available.

Totaling the definite horsepower figures for the cities listed below indicates a 20 per cent increase for the first quarter of 1940 over the first quarter of 1939.

Chicago—Central plant air conditioning systems sold in first quarter of 1940 numbered 69, aggregating 2995 hp, as compared with 51 jobs aggregating 1304 hp in 1939. In addition, 44 electric room coolers were sold in the first three months of 1940, as against 14 in the corresponding period of 1939.

Louisville—Total horsepower contracted for this year is 679.25, compared with 281.35 in the corresponding months of 1939. Total for 1940 should be around 900 hp, compared with 1939 total of 665 hp.

Buffalo—291 installations and 256.34 hp in first quarter of 1940 compared with 418 installations and 445.41 hp in 1939. Total horsepower during 1940 expected to exceed 1939, as many of the larger summer jobs will run into considerable tonnage.

Detroit—34 installations and 1052 hp for first quarter of 1940 compared with 29 jobs and 650 hp in 1939. This year's jobs comprise 22 central system, nine store conditioners, and three room cooler installations.

Pittsburgh—Number of installations for first quarter of 1940 almost double the number for first quarter of 1939, but horsepower about the same.

Lincoln, Neb.—No large increase expected this year over previous years. This is not due to any lack of interest in air conditioning, it is believed, but rather to the fact that Lincoln has done an outstanding job during the past four years in installing air conditioning in its commercial area and practically all large commercial buildings are totally or partially air conditioned. Additions in 1940 will depend largely on modernizing programs in various stores.

Virginia Public Service Co. territory—Three installations totalling 110.5 hp for first quarter of this year, compared with three jobs and 15.33 hp last year.

Milwaukee—First four months of 1940 show about 75 per cent of the air conditioning load reported for the same 1939 period. It is believed that 1940 will at least equal 1939, although both will be considerably below 1937, a very good year.

St. Joseph, Mo.—Air conditioning in 1940 so far exceeds same period in 1939 on a tonnage basis. Installations in 1939 were small tonnage, and so far this year are large tonnage.

Toledo—Five installations representing 150 hp closed during first quarter of 1940 compared with five jobs totaling 237 hp last year (one 121 hp job raised last year's total). Outlook for balance of year is good for small and medium size installations. Air conditioning seems to be spreading more and more to outlying business sections.

San Antonio—Five jobs and 136.75 hp for first three months of 1940, compared with six jobs and 115.75 hp in corresponding 1939 period.

Des Moines—Installations down sharply this year compared to last, with four installations and 13.88 hp as compared to six installations and 1531.25 hp in 1939 (Bankers Life Co. job of 1355 hp was included in first quarter of 1939).

Rockford, Ill.—One 25 hp job in first quarter of 1939 compared with one 3.25 unit in 1940. Air conditioning sales in this city seem to be "hit or miss."

Cincinnati—22 installations and 636.75 hp for first quarter of 1940 compared with 12 installations and 203 hp in first 1939 quarter.

Washington, D. C.—15 installations and 348.75 hp for first quarter of 1940 compared with 14 installations and 560.25 hp for corresponding period in 1939 (two governmental installations totaling 136.5 hp included in '39 jobs; none so far in 1940).

Kansas City, Mo.—12 installations totaling 418 hp for first quarter of 1940, compared with 12 totaling 492 hp for first three months of 1939. Good deal of air conditioning activity right now, but impossible to say how much of it will be translated into orders.

New York City (Manhattan, Brooklyn, Bronx and Queens)—161 installations and 7586 hp for first quarter of 1940, compared with 127 installations and 6057 hp in 1939.

The New York World's Fair, which re-opens May 11, has stimulated air conditioning installations in New York, as did the Century of Progress exposition in Chicago in '33 and '34. Air conditioning is of course installed for many of the fair buildings at such expositions, and also by regular business establishments who want to attract out-of-town patrons. General public acceptance of air conditioning is also created by the resulting contact with the comfort it provides.

ASME MARKS SIXTIETH YEAR

Mechanical engineers of the United States and Canada observed last month the sixtieth anniversary of the founding of the American Society of Mechanical Engineers. It was on April 7, 1880, that 80 mechanical engineers met in the assembly room of Stevens Institute of Technology, Hoboken, N. J., and organized the ASME, which had an initial membership of 189.

The founder members promulgated the present objectives of the organization, which are to promote the art and science of mechanical engineering and the allied arts and sciences; to encourage original research; to foster engineering education; to advance the standards of engineering.

IAA ELECTS NEW OFFICERS

Henry Booth, vice-president, Shawinigan Products Corp., E. L. Mills, vice-president, Bastian-Blessing Co., and Philip Kearny, president K-G Welding and Cutting Co., have been elected president, vice-president and treasurer respectively of the International Acetylene Association for 1940. H. F. Reinhard, Union Carbide Co., was re-elected secretary. The association, pledged to foster the art and science of producing and using calcium carbide and acetylene gas, held its 40th convention in Milwaukee, Wis., last month.

AIR CONDITIONING DIVISION FORMED

The consolidation of all heating and air conditioning equipment into the air conditioning division with E. R. Walker as manager, has been announced by the Fedders Mfg. Co., Buffalo, N. Y.

Prominent among the products of the division is the complete line of "Type K" heating coils recently announced.

BUSINESS INCREASES REPORTED

Six hundred men have been added to the factory force of the York Ice Machinery Corp. during the past six months to handle the increasing air conditioning and refrigeration equipment orders secured, according to President Stewart E. Lauer. A portion of this swell in employment is the result of a number of recent successes scored by the selling organization, including a large absorption refrigeration system for special processing for Tennessee Eastman Corp., a turbo refrigeration compressor, driven by steam turbine, for the Industrial Rayon Corp., an air conditioning system for the May Co. department store in Cleveland, and comfort air conditioning systems for F. W. Woolworth Co. stores at Springfield, Ohio, Utica, N. Y., and New Brunswick, N. J. These contracts add up to a total of 4200 tons of refrigeration. The business involves about a half-million dollars.

Exclusive of sales to other manufacturers for resale, which account for a small percentage of York's total business, the corporation's sales for the six months' period ending March 31, 1940, exceeded the same period last year by 17.1 per cent. Forecasts for the next quarter ending June 30 indicate a substantial improvement over the same 1939 period.

* * *

Sales billed by General Electric Co. during the first quarter of 1940 amounted to $85,949,194, compared with $68,537,269 during the same quarter last year, an increase of 25 per cent, President Charles E. Wilson announced to the stockholders at their annual meeting last month. Orders received during the first quarter of 1940 amounted to $97,490,047, compared with $86,882,953 for the same quarter of 1939, an increase of 12 per cent.

* * *

It was announced at the annual meeting of Carrier Corp. stockholders that net income of the corporation for 1939 was $18,788.12, rather than the preliminary figure of $69,099.61, which had been announced subject to audit. The revised figure was due principally to a change suggested by the independent auditors involving crediting $45,000 to surplus rather than to expense. The figure compared favorably with a sizable loss in 1938.

* * *

George H. Bucher, president of the Westinghouse Electric & Mfg. Co., told stockholders at the annual meeting of the company that the outlook for business was "very encouraging." Orders booked by Westinghouse during the first three months of 1940, he said, were more than 30 per cent higher than during the same period last year—a total of $65,250,000 for the first quarter of 1940 as compared with $50,121,000 in 1939.

Mr. Bucher also reported that the company's backlog of unfilled orders was approximately $83,000,000 on March 31, a peak figure in the company's history. The inventory was about $66,000,000 on that date, as compared with $53,840,000 on March 31 last year, at which time unfilled orders were $46,900,000.

* * *

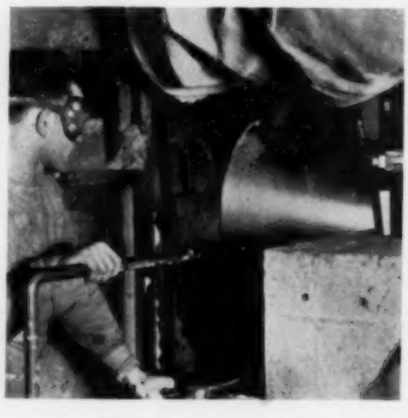
An increase of 32 per cent in factory stoker sales was registered in February of this year over the same month in 1939 and an increase of 38 per cent compared with February, 1938, according to U. S. bureau of census reports based on data furnished by 104 manufacturers. February, 1940, sales totaled 3456; February, 1939, 2612; and February, 1938, 2502.

Sales for the first two months of 1940 exceeded sales for the same period in 1939 by nearly 21 per cent—7515 units and 6216 units, respectively.

* * *

Total shipments of oil burners for January, 1939, amounted to 8738 units and for January, 1940, to 12,963 units, according to department of commerce figures.

Members of the National Mineral Wool Association are to meet in Chicago on May 15 and 16 to observe the one-hundredth anniversary of the making of this insulating material, which was first manufactured in Wales in 1840. The illustration shows a part of the manufacturing process. A jet of high velocity steam hits a stream of molten rock, slag or silica, converting it into numerous silk-like whorls and curls which are blown by the impact through the small hole in the center of the picture into a 60 ft long settling chamber. From there it is removed for final processing into batts, strips, loose and granulated wool



LANG HEADS APPARATUS SALES

Chester H. Lang, manager of General Electric's advertising and sales promotion activities since 1932, has been named manager of apparatus sales and vice-chairman of the company's apparatus sales committee. The apparatus or capital goods lines range from big turbines to tiny motors.

Robert S. Peare has been named manager of General Electric's publicity department, succeeding Mr. Lang.

PRESENTS RECORDS OF EMPLOYEES

In a bulletin entitled "Time Moves On at Young's" the Young Radiator Co., Racine, Wis., graphically presents the service record of its 357 employees. It is interesting to note that the average for each employee is five years of service, that 15 per cent of the employees have been with the company for more than 10 years, and another 30 per cent have served for periods of between five and 10 years. The company was organized in 1927.

SLAYTER TO RECEIVE LONGSTRETH MEDAL

Games Slayter, vice-president of Owens-Corning Fiberglas Corp., is to receive on May 15 the Edward Longstreth Medal of the Franklin Institute for his development of "Fiberglas." The medal is given in recognition of meritorious work in science and the industrial arts, and is awarded to Mr. Slayter for his achievement in successfully turning ordinary glass into thread-like fibers, the uses of which include thermal and electric insulation.

AIR CONDITION THIRTEEN UNITS

John R. Thompson Co. has awarded a contract for air conditioning 13 of its units in Chicago, New York, Grand Rapids, Louisville and Milwaukee. Neiler, Rich & Co. are the consulting engineers for this work.

SZEKELY PRESIDENT OF FAN MAKERS

The National Association of Fan Manufacturers, at its annual meeting in Chicago last month, elected E. Szekely, president; H. Mathis, vice-president; and L. O. Monroe, secretary-treasurer for the ensuing year.

Heating·Piping
and Air Conditioning

Vol. 12, No. 5 • May, 1940

Panel Warming and Cooling

Consulting Engineer Describes Installation in School

By Erwin L. Weber*

AMONG other innovations, the recently completed high school, civic auditorium and gymnasium building at Everett, Wash., contains an installation of panel warming and cooling. The building is one of a group, comprising the high school on the west side of Colby Ave., and on the east side, the vocational building along 24th St., the commercial building along 25th St., and the new building in the middle of the block between the latter two buildings. The central heating plant supplying the group is situated in the vocational building.

The new building is 254 ft long and 167 ft wide. The main body of the building consists of the foyer on Colby Ave., which leads to the auditorium with 1550 seats and to the balcony with 663 seats, the north and south entrances and stage in the center portion, and at a continuation of the stage level, the gymnasium, which faces on Wetmore Ave. The gymnasium bleachers will accommodate 1426 people. This makes a total seating capacity of 3639, which may be increased to about 4400 by providing chairs on the gymnasium floor. The gymnasium and stage are separated by a soundproof folding door 43 ft wide by 16 ft high. Another motor operated folding door permits the axial division of the gymnasium into girls' and boys' sections.

Heating and Air Conditioning System

A fresh air plenum space extends under the auditorium and also under the balcony. The cafeteria is under the gymnasium and the plenum chamber and kitchen are situated under the stage.

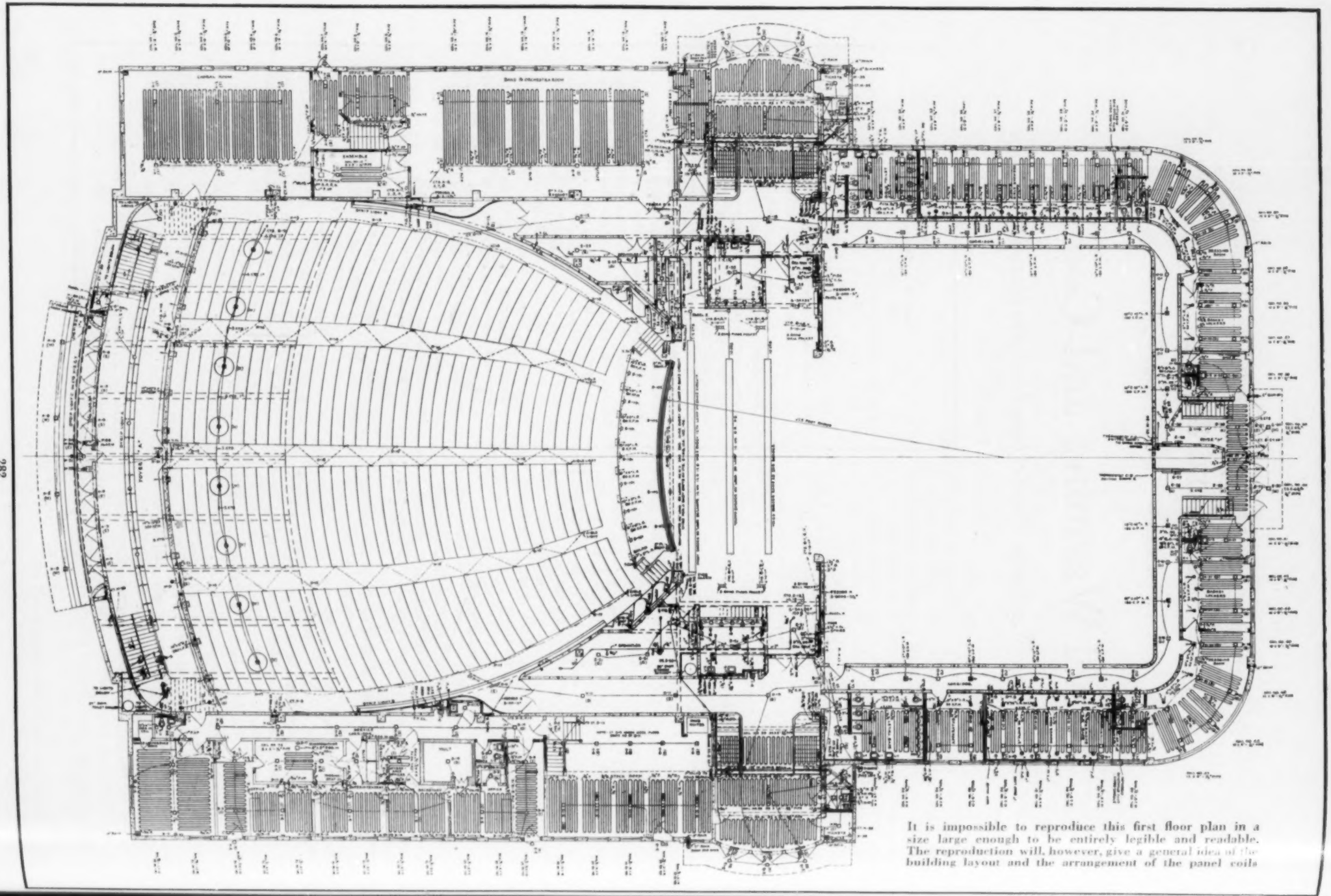
Fresh air passes through a 16 ft by 10 ft air washer with two sets of atomizing nozzles. In lieu of tempering coils, the water in the washer is warmed by a steam jacketed converter set for 53 F dew point control. The air then passes through heating coils set for 65 F dry bulb temperature. A multi-speed, motor driven, double inlet, double width fan of 80,000 cfm capacity forces the air into the plenum chamber, which is acoustically treated both on the floor and on the walls and ceiling.

The air then passes from the plenum chamber through individual reheating coils to the various sections of the building which require ventilation; namely, middle right, middle left, outside right, and outside left auditorium; right and left balcony, right and left gymnasium bleachers, and right and left cafeteria. Each of the coil dis-

*Consulting Engineer.

Summary of
Panel Warming and Cooling
By Erwin L. Weber

Among other innovations, the recently completed high school, civic auditorium and gymnasium building at Everett, Wash., includes an interesting installation of panel warming and cooling. There are steel pipe coils in the ceiling of the one story section, through which water at a maximum temperature of 130 F is circulated. A 4000 gal capacity hot water storage tank in the central boiler plant was installed to supply heat for the gymnasium showers and for the panel heating system, the water for the latter service being heated in a counter-current flow converter with a capacity of 1,000,000 Btu per hr when heating water from 115 F to 130 F and supplied with water from the storage tank at 140 F. . . . Flow water for each heating zone is derived through a three way diaphragm mixing valve in which is combined flow from the converter and return water. . . . The panel heating coils comprise some 11,000 lineal feet of ½ and ¾ in. steel pipe bent on 6 in. centers. All joints were welded and tested to 500 lb air pressure under water; a steel ball was blown through each coil to assure the absence of "inside welds" or other obstructions. . . . The panel heating system is to be used for cooling this summer, as city water at 62 F is economically available and as the dew point temperature of the outside air does not reach 60 F. . . . For those readers desiring references to other information published in Heating, Piping and Air Conditioning on panel heating or warming, and cooling, the following listing is given: Panel Warming, by L. J. Fowler, ASHVE *Journal Section*, January, 1930, pp. 47-53; Room Warming by Radiation, by Arthur H. Barker, ASHVE *Journal Section*, March, 1932, pp. 207-214; Method of Installing the Panel Heating System in the British Embassy, by Leon L. Munier, July, 1934, p. 304; American Practice in Panel Heating, by Leon L. Munier, July, 1937, pp. 424-426; Control of Body Heat Loss Through Radiant Means, by C. A. Mills and Cordelia Ogle, ASHVE *Journal Section*, November, 1937, pp. 697-699; Frank Lloyd Wright Uses Floor Heating for Johnson Wax Job, April, 1938, pp. 238-239; Cathedral Heated by Underfloor System, by T. Napier Adlam, July, 1938, pp. 464-465; Hospital Installs Radiant Conditioning System, by C. A. Mills and John Gorrell, December, 1938, p. 762; Building Designed by Frank Lloyd Wright Features Floor Heating, Air Conditioning, by Victor Walters, November, 1939, pp. 661-663; and Foreign Experiences With Radiant Heating, abstracts by Stephen Zamenhof, February, 190, pp. 98 and 102



It is impossible to reproduce this first floor plan in a size large enough to be entirely legible and readable. The reproduction will, however, give a general idea of the building layout and the arrangement of the panel coils

charge casings is provided with an intermediate acting, remote controlled shut-off damper. A duct with "superheating" coils supplies air to the foyer, where a switch gives the doorman remote control of the steam admission to the coils.

Steam at 125 lb pressure is brought underground from the boiler room to supply the converter, heating and reheating coils, stage radiation, kitchen equipment and the unit heaters in the gymnasium.

Due to the cool summers on the northwest coastal strip, no cooling means other than the evaporative cooling effect of the air washer is required.

Temperature Control for Auditorium

When people are seated close together, as in a theater, a lower air temperature is required when the house is full than when it is sparsely occupied, due to the effect of heat radiation from person to person. According to my experience, the most comfortable conditions are obtained with the air at 69 F dry bulb temperature when the house is sparsely occupied and 65 F to 66 F when the house is crowded, with intermediate temperatures for intermediate degrees of occupancy.

The coils to the auditorium, balcony and gymnasium bleachers are controlled by intermediate acting duct thermostats situated in the various branch ducts where they are naturally not readily accessible for frequently setting the control temperatures for various degrees of occupancy. Hence, remote controlled adjustable thermostats were used in these ducts. A control board is conveniently situated in the fan room, with switches for setting the remote controlled adjustable thermostats in the two top rows and switches for the remote controlled dampers in the two bottom rows.

Upward ventilation is used in the auditorium and balcony. Air is introduced under alternate seats through ventilators especially made for this installation. Each deflects the air toward the floor to assure low velocities and freedom from drafts. Vitiated air passes through grillages in the plaster ceiling to the attic space, from where it passes through insulating board ducts to the exhaust fan room which has acoustically treated floor, walls and ceiling. A double width, double inlet fan of 35,000 cfm capacity discharges the vitiated air from this room. Here are also situated a second exhaust fan which removes air from the soffit under the balcony through outlets built into the electric fixtures and a third exhaust fan which removes air from the toilets.

Gymnasium and Cafeteria

The main body of the gymnasium is warmed by four unit heaters. Air is supplied to the spaces under the bleachers and is diffused through slots in the risers. This makes it possible to supply air to the bleachers suitable for the spectators, while the body of the gymnasium is kept cooler for the players.

The cafeteria is supplied with air through grilles situated along its entire perimeter near the ceiling and all air is exhausted through the adjoining kitchen.

On the north side of the auditorium are the school board offices and on the south side are the music, choral and band rooms. All around the gymnasium, under the bleachers, are the shower rooms, dressing rooms, locker and other gymnasium auxiliary rooms. This group of rooms is one story high with concrete floors laid directly on the ground.

Panel Warming for One Story Section

The former offices of the school board were situated on the first floor of the high school building and, having no basement under them, the floors were often disagreeably cold. The school board was concerned about having warm floors in their new quarters and was considering various items, such as a rifle range, etc., to establish an excuse for building a basement. The boiler plant was also insufficient to supply all the heat requirements of the group and no funds for plant enlargement were available. To assure warm floors without the use of a basement and to make the best use of the existing boiler capacity, it was decided to use panel warming for this group of rooms in the single story section of the building and to install a 4000 gal capacity hot water storage tank in the boiler room to supply the gymnasium showers and heat for the panel warming system.

Construction view showing coils on form

In panel warming systems, the radiant rays from the ceiling impinge upon the floor and there produce heat, in the same way that the sun's rays heat the ground and other surfaces.

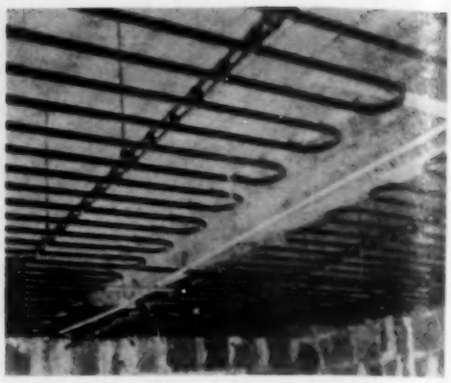
Hot water from the storage tank is mixed with cold water through a thermostatically controlled mixing valve to give a resultant tepid water supply at 115 F. This is used as the normal hot water supply to the showers and together with a cold water supply is connected to each individual shower mixing valve. This avoids possibility of scalding and permits the storage water to be heated above the boiling point. The panel warming system is designed for a maximum water temperature of 130 F.

The 4000 gal of water in the storage tank can be heated to 220 F in 1½ hr and will supply the panel warming demand at full load until the water drops to 140 F, thus giving a heat storage capacity of $4000 \times (220-140) \times 8.3$ or roughly 2,600,000 Btu. The panel warming system has a heat transfer capacity of about 550,000 Btu per hr. Hence, it may be operated during cold weather for nearly 5 hr from the storage tank, or the panel warming system and gymnasium showers may be operated together for over 3 hr from the storage tank, without placing any demand upon the boilers.

The water for the panel warming system is heated in a countercurrent flow converter which has a capacity of 1,000,000 Btu per hr when heating water from 115 F to 130 F, while being supplied with water from the storage

Music room

Board room



Construction view showing ceiling coils

tank at 140 F. It contains 250 sq ft of heating surface made of copper tubing. The converter is also provided with a cold water connection for cooling the panel system by means of city water during the summer. Neither the water from the hot water storage tank, nor cold city water, is circulated through the panel system as the continuous introduction of new water introduces air into the system and may cause scaling or pitting of the pipe.

A motor driven centrifugal pump with a capacity of 135 gpm at 30 ft head circulates the water in the system through four thermostatically controlled zones; offices, music rooms, girls' gymnasium and boys' gymnasium. The flow water to each zone is derived through a three way diaphragm mixing valve, supplied with flow water from the converter and with return water from the pump discharge, wherein it is mixed to the temperature demanded by the room thermostat of each zone. The common return enters the suction inlet of the pump.

11,000 Ft of Pipe for Coils

The panel coils contain nearly 11,000 lineal feet of ½ and ¾ in. steel pipe bent on 6 in. centers. All joints were welded and tested to 500 lb air pressure under water and a steel ball was blown through each coil to assure the absence of "inside welds" or other obstructions.

The coils are embedded in the concrete ceiling slabs in all the gymnasium auxiliary rooms. The soffits were finished with three coats of plaster work, with a scrim embedded in the last coat. The offices and music rooms all have furred ceilings and the coils are wired to 1¼ in. pipe battens hung from the roof slabs. The first coat of plaster was carefully "pushed through" the metal lath to give an intimate contact with the coils. A second coat of plaster was next applied and in the third coat of plaster, a scrim was embedded while the plaster was being "floated on."

The flow and return mains are run in the space above the coils. A supply branch to each room drops down in the inside partition, is provided with a shut-off and drain valve and then rises to supply the panel coils, which discharge individually to the return main through an equalizing non-reflux elbow.

The panel warming system has been in operation since last September and has given excellent satisfaction. The floors, walls and windows have a notably higher surface temperature than in conventionally heated rooms.

The system is to be used for cooling the offices this summer, as city water is economically available at 62 F, and as the dew point temperature of the outside air never exceeds 60 F, condensation should not form on the ceiling. As the dry bulb temperature of the air seldom reaches 90 F, a considerable and sufficient "panel cooling" effect should be attained without the use of mechanical refrigeration.

The building was designed by Earl W. Morrison, Architect, and the electrical, mechanical and sanitary equipment was designed by the author. I. G. Navarre Plumbing & Heating Co. installed the mechanical and sanitary equipment.

The panel warming and cooling system was licensed from Richard Crittall & Co., Ltd., of London, through Wolff & Munier, Inc.

Dam Is Refrigerated

By Walter E. Becker*

Wet concrete generates an amazing amount of heat until it becomes "set." In ordinary applications of concrete, such as walks, roads, walls, masonry and the like, this heat is quickly dissipated to the air, but in a massive body of concrete such as that of the new $11,000,000 Marshall Ford dam being built at Rutledge, Texas, heat dissipation becomes a real problem.

In tests of existing dams, interior temperatures of well over 100 F have been encountered several years after their completion. The concrete continues to contract until all heat is removed; consequently the dam cannot be a complete and sound structure before normal temperature is reached.

Piping will be built into the dam as the concrete is poured, and an ammonia refrigeration system will cool 720,000 gal per day of water to 40 F and circulate it through this piping, carrying off the heat generated by the cement. Cooling capacity of the system is equal to the melting every 24 hr of 175 tons of ice. It is estimated that the dam will be completely cooled in from two to three months as contrasted to several years by natural processes.

Refrigeration has also played a part in the construction of other dams. Before the Hoover dam was built, the government established testing laboratories at Denver to determine characteristics of concrete under conditions similar to those within the finished dam.

*Southern Regional Manager, York Ice Machinery Corp.

Types of Drawings Used in Power Piping Drafting

By Albert Jorgensen*

THE functions of the power piping draftsman and the problems with which he is confronted were discussed in a general manner in April. The drawings which usually are supplied to facilitate the fabrication and installation of a power piping system were also mentioned; these are the plot plan, general building plans, piping diagrams, piping assembly drawings, details of pipe supports, and shop drawings. The purposes and characteristics of the first three types of drawings listed were considered and examples of piping diagrams were presented; we continue this month with a discussion of other types of piping drawings.

Under the piping assembly drawings are included the numerous large scale ($\frac{1}{4}'' = 1'\text{-}0''$ to $\frac{1}{2}'' = 1'\text{-}0''$) plans, elevations, and miscellaneous sections which are necessary to show the piping and its relation to the equipment and to the building. In a sense they may be called assembly-detail drawings since they are quite fully dimensioned. They are detailed to the extent to which the engineer desires to exercise control. Any details omitted are to be supplied by the fabricator, who must supply shop drawings for approval. In the creation of such drawings, the main steam lines and boiler feed and condensate lines are drawn first, in most instances, and the minor lines fitted into the remaining space, revisions in the former sometimes being necessary to make possible good design in the latter.

Of pipe drawings, these are the most difficult to draw and interpret, but since power plant piping is complex, these difficulties are to be expected. Assembly drawings are made as a necessary part of the process of laying out a power piping system to make sure that the piping can be installed, and to insure plant operating convenience and accessibility for repairing the equipment and the piping system. The drawings are complete enough to serve as guides for estimating, the making of shop drawings, and installation.

Since there is a limit to the size of sheet which can be handled conveniently, and since the scales used on piping assembly drawings are unavoidably quite large, it is necessary to separate the power plant into logical divisions and make a series of drawings.

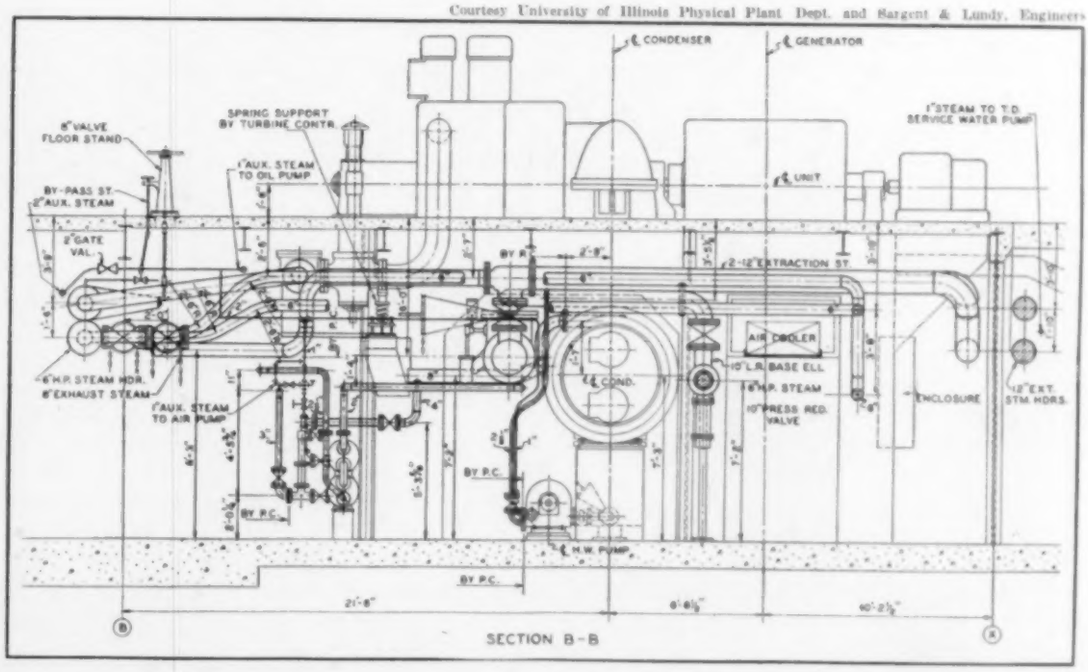
While these piping assembly drawings have been referred to as plans, elevations, and sections, actually they are all sectional views. The plan views are similar to architectural floor plans which in reality are horizontal sections taken at various levels to reveal details as desired. The elevations are projections on vertical section planes which cut through the building. On any one assembly drawing, the locations of section planes which show edgewise in the area represented on that drawing, are indicated. All closely related drawings carry cross-reference notes. The representation is confined mainly to that which is visible. Invisible material is represented sparingly by dotted lines. The insulation is not commonly shown on the assembly drawings, but space for it must be considered in making the piping layout.

Examples of piping assembly drawings are given here as Figs. 1, 2, 3 and 4. Figs. 1 and 2, and the piping diagram on p. 226 of the April issue, were taken from the same set of piping plans which included 16 sheets of piping assembly drawings. These figures were taken from plans which represented an advanced stage in the design. The final plans differ in some respects, however.

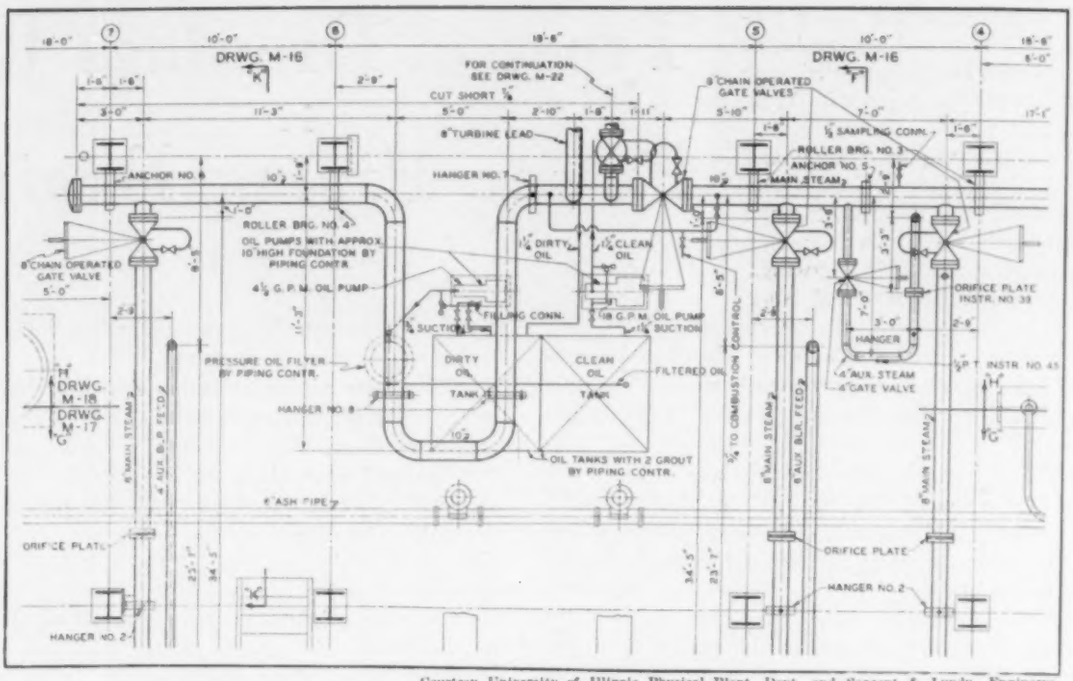
Figs. 3 and 4, and the flow diagram on p. 227 of the April article, were taken from another set of piping

Fig. 1—Longitudinal section of 3000 kw condensing unit piping (partial drawing). Original scale: $\frac{3}{8}'' = 1'\text{-}0''$

Courtesy University of Illinois Physical Plant Dept. and Sargent & Lundy, Engineers



*Assistant Professor, General Engrg. Drawing, University of Illinois.



Courtesy University of Illinois Physical Plant Dept. and Sargent & Lundy, Engineers

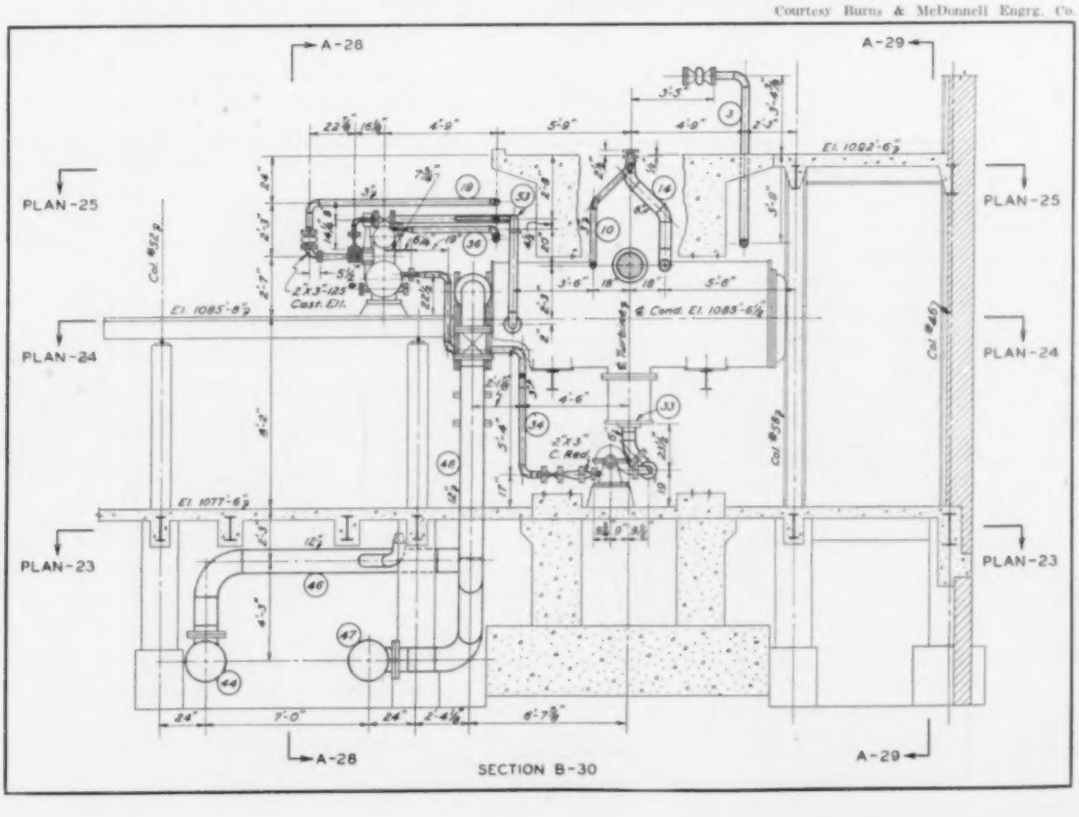
Fig. 2—Lower basement plan of boiler room piping (partial drawing). Original scale: $\frac{3}{8}'' = 1'\text{-}0''$

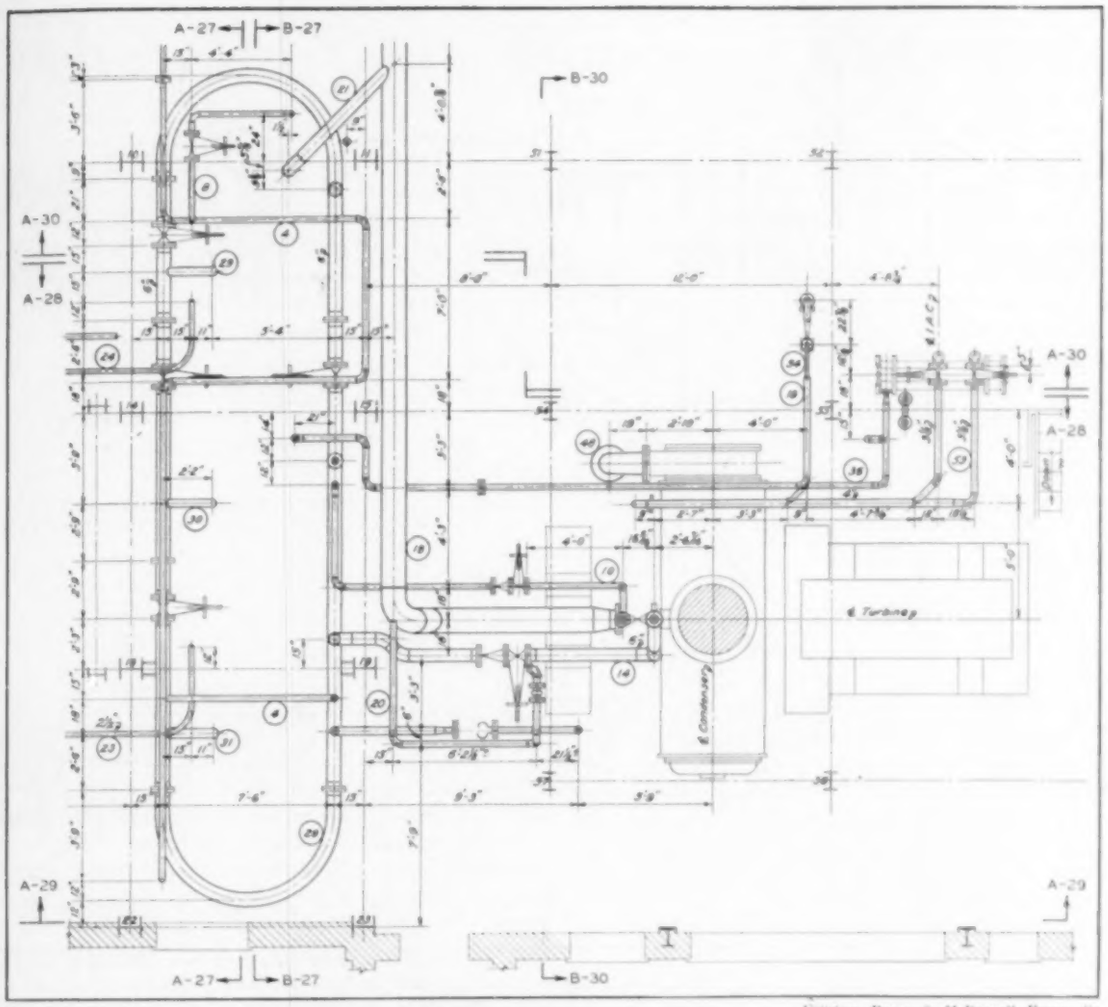
drawings which contained nine sheets of assemblies, including separate drawings of the small piping around the turbine. In both instances the plans and specifications were prepared for bidding and the piping contractor was required to submit shop drawings. Figs. 1, 2 and 4—reproduced this month—show only portions of the corresponding original drawings.

On this type of drawing it is common practice to provide contrast between that which is a part of the piping contract and the other material shown. That which is included in the piping contract is shown by means of heavy lines, and such things as the equipment, the building, and that part of the piping which is not to be installed by the piping contractor, is represented by light

Fig. 3—From sheet of floor plans and sections, original scale $\frac{1}{4}'' = 1'\text{-}0''$

Courtesy Burns & McDonnell Engrg. Co.





Courtesy Burns & McDonnell Engrg. Co.

Fig. 4—Plan below 1092'-6" (partial drawing) Sheet designation: "Plan below operating floor." Original scale: ¼" = 1'-0"

lines. The dimensioning on these drawings follows architectural and structural drawing practice in that solid dimension lines are used and the dimensions in feet, inches and fractions thereof are placed above the dimension line. The dimensions given are those which are to obtain at the installation temperature. The specifications usually contain a statement to the effect that the contractor is not to follow the drawings blindly. He should check the dimensions given on the drawings and make field checks on the dimensions of that material already in place before proceeding too far with the fabrication of the piping.

In the set of drawings from which Figs. 1 and 2 were taken, the north-south rows of main columns were represented by letters and the east-west rows by numbers, so that any main column may be designated by a letter-number combination. Fig. 2 shows that in this case the pipe supports on the H.P. (high pressure) steam lines were located on the assembly drawings supplied to the contractor. In this same set of drawings the larger pipes were represented by means of the double lines, the smaller pipes by single lines. Several other plan and sectional views were required to represent the piping in the vicinity of that shown. The note "by P. C." means of course "by piping contractor" and indicates that the piping to the point designated is to be supplied and installed by the piping contractor, the remainder by others.

For purposes of correlation each column was num-

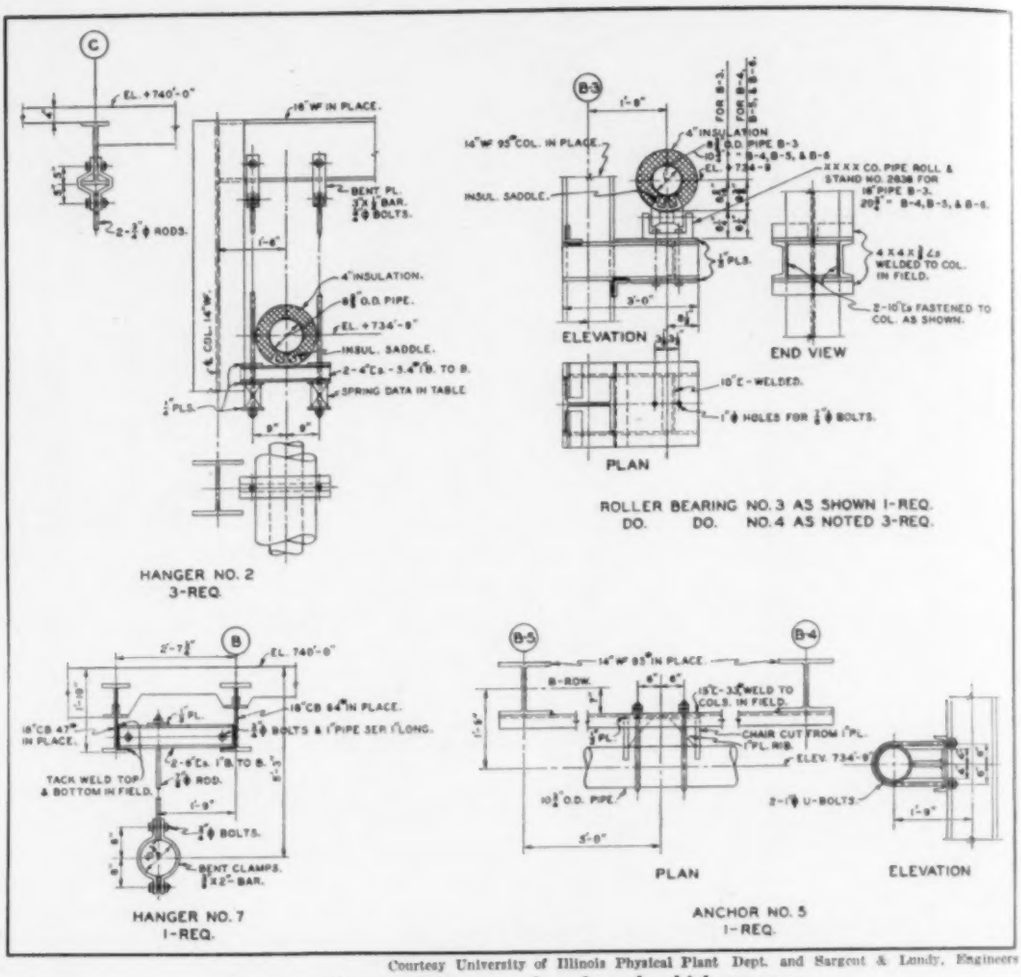
Summary of
Types of Drawings Used in
Power Piping Drafting
By Albert Jorgensen

As Professor Jorgensen pointed out last month, recent advances in the sciences and arts involved in power piping design and installation complicate the problem of the piping designer and draftsman, make imperative a greater degree of control through the media of drawings and specifications. The drawings which facilitate the fabrication and installation of piping include the plot plan (the scale being on the order of 1 in. equals 20 ft to 1 in. equals 100 ft), general building plans (scale about ⅛ in. equals 1 ft), piping or flow diagrams, assembly drawings (scale, ¼ in. equals 1 ft to ½ in. equals 1 ft), details of pipe supports, and shop drawings. . . . Plot plans, general building plans, and piping drawings were discussed last month, and piping assembly drawings and details of supports are considered this month. . . . A third article will complete the discussion next month

bered on the drawings in the set from which Figs. 3 and 4 were taken. These drawings were selected because they bring out the fact that a large number of drawings are necessary to represent complex piping. In this set of piping plans the small piping around the turbine was represented on separate drawings.

In the detail of Hanger No. 2, Fig. 5, reference is made to a table in which spring data are given; this table is not reproduced here. The information in the table included pipe load, number of springs, load per spring, amount of pipe movement (horizontal or vertical), diameter of wire in springs, outside diameter of coil, number of coils, free length, and erection length when cold.

[This discussion is to be concluded in a third article.]

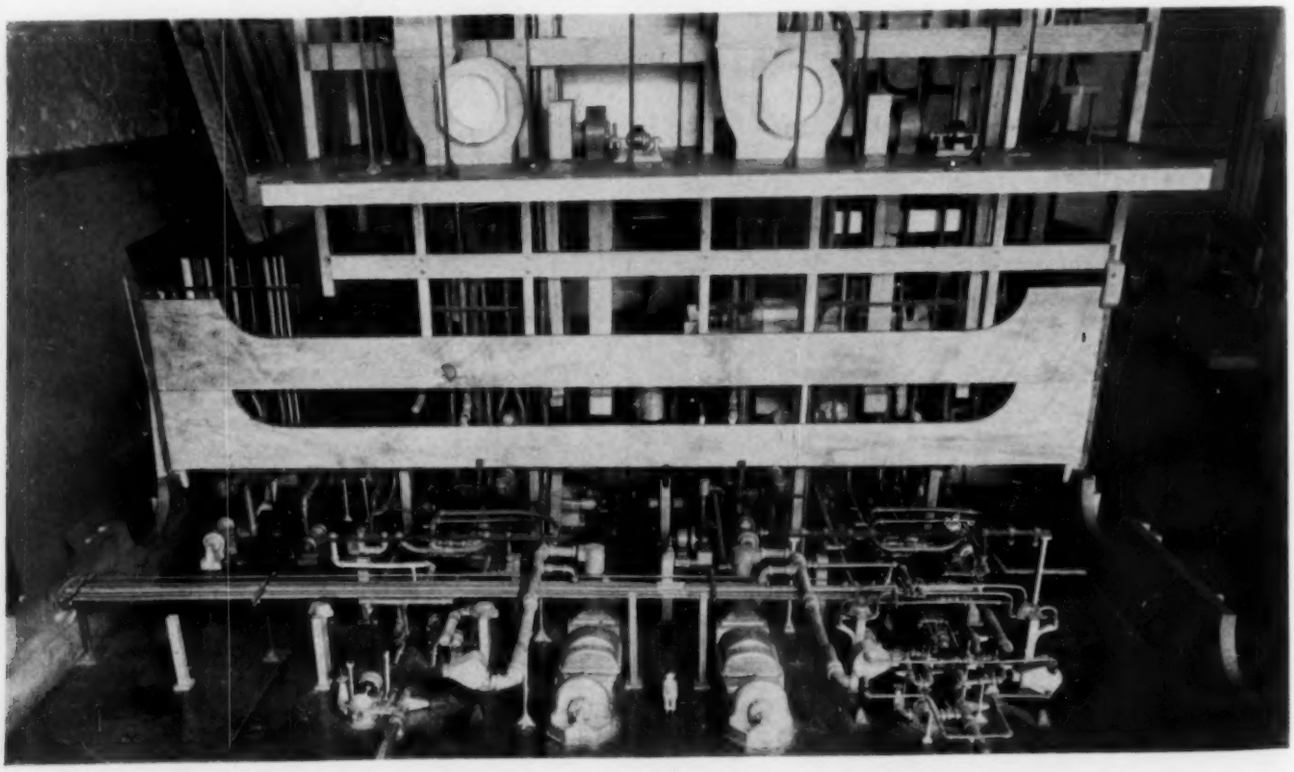


Courtesy University of Illinois Physical Plant Dept. and Sargent & Lundy, Engineers

Fig. 5 — Hangers, bearings and anchors for high pressure steam piping (partial drawing). Original scale: $\frac{3}{4}" = 1'-0"$

Use of models as an aid in the design and lay out of power plant piping will be considered in the next article on piping drafting

Courtesy The Detroit Edison Co.



The Air Conditioning Contractor

By John H. Carter*

IT WILL be a long time before all air conditioning jobs are handled by consulting engineers, who make complete layouts and draw up specifications which cover the engineering fully. Until that time, the contracting organization in air conditioning will have to continue to do some of the engineering. Needless to say, this engineering function increases the contractor's cost of doing business. Where the contractor has to make a design, and submit a layout and quotation to the customer for possible revision after revision, the mark-up will have to be greater. If each layout averages $100 cost, for example, and the contractor gets one job out of every four jobs bid, he will have to include a $400 charge somewhere in his mark-up. The customers may some time realize that it would pay to have a consulting engineer prepare one layout which, on the above basis, might cost around, say, $200.

If the contracting organization is large enough to support one or more engineers, they should be the best obtainable. A good engineer can mean the difference between profit and loss, and he can be of the greatest help in sales work by analyzing service difficulties and by devising ingenious layouts which do the job more economically or better.

The engineer will usually be paid on a salary basis, and the range of salary is wide. Even after the past decade of activity in air conditioning, there are none too many really first class men available. Some contracting organizations have found that the most practical method of getting a good engineer is to train a man themselves. They pick a recent graduate who has made an exceptional record in engineering school, start him off at a moderate salary, and let him learn the business their way. As the earnings increase, the engineer's salary can grow with them.

The Superintendent

An organization of four or five key men, or even a smaller set-up where service and overhaul work is an important part of the business, can afford to have a full time superintendent. The item of labor cost is so important in the average contract that it deserves close attention by a specialist. The superintendent will probably be a man who has learned his contracting and engineering the practical way, quite possibly as a steamfitter. He should be able to earn his salary many times over by getting the best results, in quality and in speed, from the men under his charge. If he is the right type of man, he will be able to hold the best workmen with the organization by assuring them steady work on overhauls and service as well as on new construction.

The best advertising comes from satisfied customers in the engineering-contracting business. The customer sees the sales engineer during the week or two that the job is up for closing, and he may get acquainted with the general manager in matters of adjustments or collections, but the representative that he really remembers is the superintendent. If the work is well and smoothly done, and is finished on schedule, the superintendent is the man to thank, and the customer will spread the word that it is a fine organization. If the superintendent is undiplomatic, or incompetent, or too talkative, or if he lets the customer get the idea that there were some things wrong about the engineering, the job is poisoned.

The Manager

Some one individual has got to knit the various functions of the contracting organization together, run the office, raise the money for payrolls, and see that the collections come in. He will have to do the buying, see that the books are kept properly, watch the inventories of miscellaneous stocks, check the figures and contracts of the sales engineers, and look over the engineering from the commonsense viewpoint. In the small organization these duties may be handled by one of the sales

Summary of
The Air Conditioning Contractor
By John H. Carter

An engineer with one of the oldest heating, ventilating and air conditioning contracting companies in the country—a regular reader of HPAC—recently was given the job of re-organizing the entire outfit along modern lines. He wrote HPAC's editors for some information to assist him, and in his letter said he'd like to see some articles on the subject in HPAC. We asked Mr. Carter to prepare something on the matter, and the present discussion is part of the result; it supplements an earlier article by Mr. Carter published in March. . . . The author points out this month that all air conditioning jobs are not yet handled by consulting engineers, and until this is the case the contractor must continue to do some engineering. The contractor's engineers should be the best available, for a good engineer can make the difference between profit and loss. Another important member of the personnel is the job superintendent; for one thing, he's the man the customer really remembers. The manager of the entire business has duties which—though somewhat intangible—are highly essential. He must coördinate all the other functions, be able to "smell out" trouble in a potential contract, judge the business risks involved. Promoting good will and the capital requirements of an engineering-contracting concern are considered also in concluding this month's discussion. . . . It is planned to publish more of Mr. Carter's articles on contracting—and contributions from others—in future issues. The editors will be interested to hear from readers of HPAC who would like specific points discussed

*Kupferle-Hicks Heating Co.

engineers, or in a large organization the manager may be assisted by a bookkeeper, one or more secretary-stenographers, and a stock clerk, plus a part or full time accountant. His work cannot be readily analyzed, because it covers so much ground—where any other members of the organization fall short in their duties, his duties are correspondingly increased.

It is in this one function of management that most of the unsuccessful air conditioning contractors may find their trouble. The manager has to be able to "smell out" potential trouble in a contract, even though it may be beyond his depth in a technical way. He must be able to decide which contracts should be accepted, and which turned down, from the credit viewpoint or from the viewpoints of risk or of capital requirements. He has to have an instinctive judgment which will tell him just how far the organization can safely go in volume of sales, with relation to working capital and bank credit. If, as is often the case, a contracting concern is being backed financially by a business man with money to invest, this is the logical position for him to fill—to guide the organization and to keep an eye on his investment (provided, of course, that he is adapted to this exacting kind of work).

The handling of mass distribution types of equipment, to supplement the contracting volume and to smooth out the sales curve, has by definition been considered as a subordinate activity in the type of organization under consideration. There are of course many organizations where the reverse is true, but the nature of the set-up is greatly different for these merchandising distributors, and the suggestions given above would have to be considerably modified to apply. Where a crew of semi-skilled salesmen is to work on merchandising, it will probably be most practical to have them report to an experienced supervisor.

If a line can be taken on which can be sold by the regular sales engineers of the contracting organization, and where quotas, inventories, promotion and other requirements are not severe, it may prove very helpful in diversifying the coverage. Its principal benefit may, indeed, consist of widening the contact with the public. The merchandiser can show the engineering contractor much in the way of building up a demand among that part of the public which the contractor rarely if ever approaches.

Promoting Good Will

One function has so far been neglected in this discussion. No matter how averse the contractor may be to buying publicity and advertising, he spends money for it in one way or another. His appeal to the public may not be in purchased newspaper space, or on the billboards, or in the exhibits at the state fair, but he is spreading the news about his abilities in some manner, and at a certain expense to himself. The way most commonly employed is to keep the customer so satisfied that he will spread the news by word of mouth among his friends. This is of course the finest kind of publicity which it is possible to get. It must be considered, however, that it costs money, and this expense should be kept in mind in its proper relationship to the business done. Giving the customer that extra bit of attention, the free service work which he is not strictly entitled to, the extra material to make the job a better one, is an investment in building up good will, whether or not the contractor consciously analyzes it in that way.

The ethical contractor will take the responsibility for putting in the right job, even though he may have overlooked some of the items of cost in making up his bid, if he had been given a free hand in designing the layout. Apart from this consideration, however, there are many ways in which the contractor can spend extra money in keeping his customers happy and bragging. Some contractors figure that they will spend perhaps $2,000 or $3,000 a year in this manner, out of a total volume of around one hundred times that much. If the building of good will can be held down to 1 or 1½ per cent of sales, it is a very good proportion. Nothing can buy good will for the incompetent or unethical contractor, but the capable organization should not overlook this aspect of the business.

Capital Requirements

The overhead will include, in addition to the salaries and expenses of the employees, the expenses of rent, light, heat, telephone, office supplies, auditing, legal services, insurance, printing, interest and depreciation on machinery and equipment, etc., etc. Wherever possible, the costs of extra employees required for specific jobs should be charged to those jobs rather than spread through the general overhead.

It is puzzling to the uninitiated to see the disproportion between the size of a large air conditioning contract and the rating of the contractor who handles it. The capital requirements for contracting air conditioning are severe, but the capital needed consists largely of skill and reputation, and the money requirement is secondary. A well-established contractor will have credit at his bank which will allow him to borrow for his payrolls and incidental expenses during the progress of a large contract. His contract terms may call for payment monthly to the amount of 85 per cent of the valuation of the work so far installed, which practically covers his costs. His major suppliers, with whom he has probably been doing business over a period of years, will usually extend open account terms to him. As a result, his cash requirements are mainly to meet payrolls between the monthly settlements, plus a few incidental expenses not covered by open account, plus the overhead.

The working capital requirements will be increased by the carrying of time payment contracts, which are more often encountered in the smaller jobs. Not all of this paper can be discounted at a financing institution. Where payments are in default, and the contractor's endorsement is invoked, it can impose a burden on his capital resources.

Cornell University's new constant temperature room embodies innovations in design which facilitate research in air conditioning, heat transfer and related fields. It is 26 x 29 ft and 12 ft high, with walls, ceiling and floor insulated with 8 in. of cork. A cooling room and instrument room are also provided; the testing room is completely free from heating and cooling apparatus, a feature designed to eliminate possible errors in experiments.

Getting Boilers Into a Tight Spot

Boiler Plant Installation in Apartments Replaces Purchased Steam

By Edwin A. Kingsley* and R. Stewart Bruns, Jr.†

Summary of
Getting Boilers Into a Tight Spot
By Edwin A. Kingsley and R. Stewart Bruns, Jr.

The installation of boilers in an existing building when the heating plant is being modernized or changed over often presents quite a problem—particularly so when steam has been purchased from an outside source and no boiler rooms or chimneys were provided in the original design, as was the case at the Beaux Arts Apartments in New York City. These apartments comprise two 17 story buildings separated by a street. Surveys showed that certain portions of the basements had not been excavated to the same depth as the major parts, and the only space available for the new boilers was in a corner of each building where the rock had only been leveled off to carry the building column footings . . . . . Boiler pits were excavated, but as headroom was limited and since considerable space was necessary for proper combustion the problem of finding suitable boilers was a poser, as was the necessity of entering the boilers in small sections . . . . . Boilers of special design with the fireboxes made longer than usual and cut down in height were selected. With the type of boiler used, the shell may be separated from the firebox by unbolting the flanges of the circulating connections. Also, the manufacturer built the firebox in separate halves which could be bolted together, and the complete shell was constructed with the ligament or spacing increased between the tubes in the upper and lower banks so that the whole shell could be cut in half longitudinally and welded together in the boiler room. Further redesigning allowed the shell to be cut into three approximately equal lengths and the section containing the lower tubes to be cut horizontally almost at its center line. The firebox was shipped in four sections . . . . . As there was no headroom for piping to rise vertically from the boilers as installed, a special side steam outlet was devised with its center line tangent to the top of the shell and at right angles to the main axis of the boiler . . . . . For rolling the upper bank of tubes a motor was coupled to the shaft of an expander through an old automobile gear shift; the first gear gave the desired speed reduction and sufficient power for rolling; when the expander was finally "home" the gear shift was put in reverse and the expander withdrawn . . . . . Stacks were also a problem, but were put on the corner of each building at the rear, at least 18 in. away from any window opening. Underground flues were cut out of rock along the building walls and the yard level was restored . . . . . The boilers are fired with rotary cup oil burners suitable for No. 6 oil. While performance records are not yet available, it is expected that steam will be produced for one-half the cost when purchased from an outside source

WHEN it was decided to install boilers for heating the Beaux Arts Apartments in New York City instead of using steam purchased from an outside source, a most difficult problem was presented insofar as finding the necessary space for them and for the chimneys. No provisions had been made for boiler rooms or chimneys when the buildings were originally designed.

The Beaux Arts Apartments consist of two buildings, one on the north and the other on the south side of East 44th St., not far from the East River. The buildings are of the studio type and have considerable glass area. Each is 17 stories high and each contains approximately 350 studio apartments.

Surveys of the buildings were made and it was found that certain portions of the basement in each building had not been excavated to the same depth as the major portion of the basement and, due to certain differences in design, a separate treatment for each was necessary. The only space found available for boilers was at the rear east corner of each building where the rock which covers most of this district had only been leveled off to carry the building column footings.

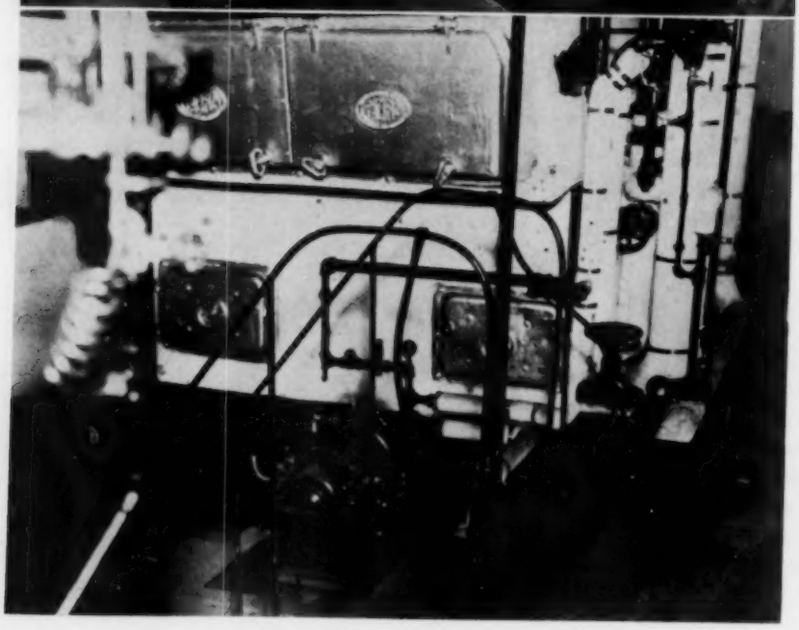
While the column bases were fairly close together, it was decided that if the quality of the rock permitted we could go down several feet below the column bases. Rock tests were made and were found to be fairly good; the results of the tests were submitted to the city department of housing and buildings and the plans for the boiler pits were approved for construction. Since headroom in the boiler pits was limited, and since considerable space was needed for proper combustion at over-rating (which would occur at times when only one boiler would be in service), the problem was to find suitable boilers which would fit into the limited spaces and still provide necessary steam requirements. Also, we were confronted with the necessity of entering the boilers in small sections.

We finally decided upon the installation of two 180 hp front smoke outlet boilers in each of the buildings, each boiler containing 1800 sq ft of heating surface and of special design in that the fireboxes were made longer and the firebox height cut down from standard dimensions. Certain other details were altered to suit the conditions.

Boilers of Special Construction

A major problem was constructing the boilers so that they could be gotten into the new boiler rooms. As a characteristic of its normal construction, the shell of the type of boiler selected may be separated from the firebox by unbolting the flanges of the circulating connections. With this as a starting point, the boiler manufacturer built the firebox in two separate halves which could be bolted together; this gave some additional leeway in entrance requirements. The next step was to build a complete shell with the ligament, or spacing, increased between the tubes in the upper and lower banks, so that the whole shell could be cut in half longitudinally and

*Consulting Engineer.
†Pacific Steel Boiler Div., United States Radiator Corp.



Top to bottom—The pieces of the boilers were trucked to the job site and rigged through the 42 in. wide service doorways . . . . . Lack of headroom necessitated special treatment of the main steam outlet; there was no room for any piping to rise vertically so a special side steam outlet was devised with its center line tangent to the top of the shell . . . . . Each boiler is fired with a rotary oil burner for No. 6 oil

welded together in the boiler room. This construction, in conjunction with a divided firebox, still further decreased the necessary size of the opening required.

With such possibilities in mind, the boiler manufacturer carefully checked the building, and it became necessary to consider still further reduction of the length of the pieces to be brought into the building, the shell presenting the main problem.

To accomplish this reduction in size, it was necessary for the boiler manufacturer to start from scratch and redesign the boiler. First, the requirements of the job had to be met; these consisted of (1) heating surface, (2) combustion volume, (3) over-all height of the completed unit, and (4) smokehood location to permit the use of a common breeching for the two units in each boiler room which were to face each other.

The latter condition dictated the use of a front smoke outlet boiler. The over-all height and combustion volume requirements necessitated the redesigning of the firebox; it had to be truncated and elongated. It was then noted that a shell could be designed whose length was such that the firebox was approximately two-thirds as long as the upper tubes; or, in other words, the lower tube bank was, roughly, one-half the length of the firebox. This allowed the shell to be cut into three approximately equal lengths and the section containing the lower tubes could be cut horizontally almost at its center line and shipped to the job with its tubes in place. There remained three other segments of almost equal length—the three pieces that made up the upper section of the shell and were to contain the upper tubes. The firebox could be shipped in four sections; the four sides, with the inner and outer sheets stayed together. The result of this study was an assembly drawing which, after some slight modification, was finally approved by all parties concerned.

The shell diameter of the completed boiler is 75 in. inside; therefore, the half shell segments could be brought through the 42 in. wide doorway which served as a service entrance. Each segment was approximately 5 ft long, an additional cut

being made to separate the gas chamber behind the rear tube sheet with its heavy cast iron flue door ring and doors.

When the pieces were trucked to the job site, they were rigged through the doorways mentioned above into the service hallways, then lowered into the basements. A hole was cut in the floor in the north building and a portion of the stairway with a short flight of steps and a landing was removed in the south building.

Once in the basement, the parts were rigged into their respective boiler rooms through openings made in the walls. In the boiler rooms, a long pit was excavated in the solid rock; this pit was the width of the boiler settings, of varying levels, and of sufficient length to permit the boilers to be set as previously described. As the headroom above the natural rock level was only about 5 ft, a further passage had to be cut from the basement hallway to the space between the boilers.

At this point, a crew of men from the factory were ready to go to work. The firebox was set up in the pit and welded. Temporary bracing was used to assure correct alignment of the sides and ends. When completed, a hydrostatic test was applied and the firebox was left in the pit until the shell pieces were welded together and in place. A gallows frame was erected, bearing on the common brick walls of the boiler settings, to hold the shell segments, as they were rigged separately in position and to cradle the shell as it was rotated, to permit the girth seams to be welded. Clearances were so closely calculated that with the completed shell held hard against the ceiling, the firebox could be put into place under it only by using 1 in. pipe for rollers.

Lack of headroom necessitated a special treatment of the main steam outlet. There was no room for any piping to rise vertically from the boilers, so a special side steam outlet was devised with its center line tangent to the top of the shell and at right angles to the main axis of the boiler. The steam nozzle was situated near the front of the boiler to accommodate a predetermined header arrangement. To assure reasonably dry steam, a dry pipe in the form of a tunnel was constructed inside the steam space within the boiler shell, with its entrance near the rear or quietest part of the boiler, and terminating at the location of the outlet. Steam is admitted to the tunnel at the top and condensate is drained through several 1 in. pipes along its length.

To roll the upper bank of tubes, of which there are 107 in each boiler, an electric motor was coupled to the shaft of an expander through an old automobile gear shift picked up in a junk yard. First gear gave the desired speed reduction and sufficient power for rolling, and when the expander was finally "home" the gear shift was put in reverse and the expander withdrawn. This apparatus was secured to a heavy plank and suspended from a cable stretched across the front of the boiler so it could be brought into position in front of each tube as it was moved across the tube sheet.

After rolling the tubes, all the outlets were plugged and a 60 lb hydrostatic test was applied. As a further protection to the purchaser, the boiler manufacturer's test was supplemented with a test by the insurance company, whose inspectors had made periodic visits as construction progressed and who certified the completed boilers.

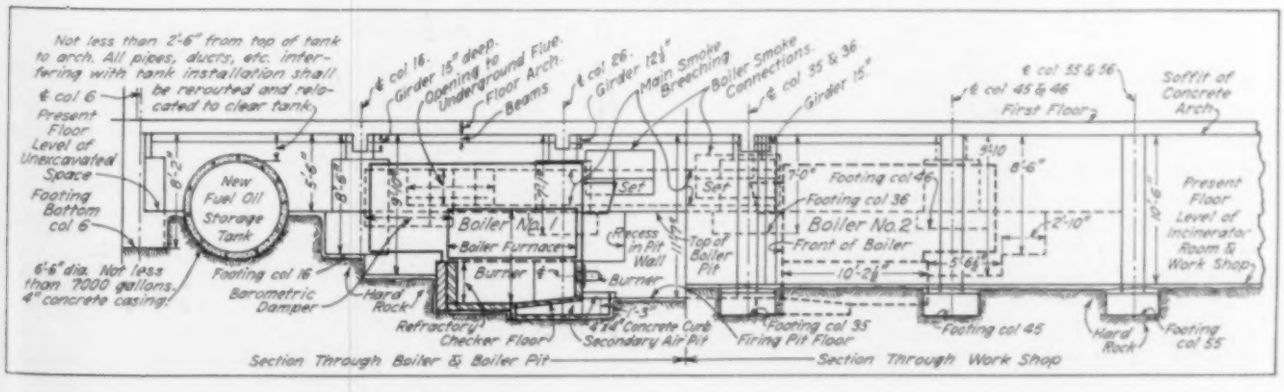
At this point, the boiler men's hardest work was done. Finally the fire doors were hung, the smokehood and rear flue chamber, with their heavily insulated doors, were put in place and the trimmings were turned over to the piping contractor.

At first it seemed we were going to be stymied for stacks since the windows were quite close together but finally the department of housing and buildings permitted us to place the stacks on the east corner of each building, at the rear, where they would meet the requirements of being at least 18 in. away from window openings. The stacks were made of ¼ in. steel plate, welded together in flanged sections to facilitate erection. A substantial brick foundation was set on bedrock in the rear yards and carried up to the second floor level. Suitable brackets were provided and attached to the steel work of the building for holding the stacks in position. Since the boilers were set some distance from the stacks and it was desired that the yard should not be encroached upon, an underground flue was cut out of rock along the building wall and the yard level was restored. The boilers were placed just far enough apart for tube renewal and the fronts and breeching outlets face each other. The breeching was yoked together and run along in the space between the boilers and the building wall, on top of the upper basement rock level. At a point in the main breeching just before it extends through the building wall, a barometric damper is set in each building.

Each boiler was provided with a fully automatic, rotary cup oil burner suitable for No. 6 fuel oil, furnished with a control for automatically governing the size of the flame to suit steam requirements.

The plans and specifications were prepared by the office of Edwin A. Kingsley, Consulting Engineer, under the supervision of Francis J. Knoll, Associate.

Section through one of the boiler rooms


Not less than 2'-6" from top of tank to arch. All pipes, ducts, etc. interfering with tank installation shall be rerouted and relocated to clear tank.
℄ col 6
Present Floor Level of Unexcavated Space
Footing Bottom col 6
New Fuel Oil Storage Tank
6'-6" dia. Not less than 7000 gallons, 4" concrete casing.
Footing col 16
Barometric Damper
℄ col 16.
Girder 15" deep.
Opening to Underground Flue.
Floor Arch. Beams
℄ col 26.
Girder 12½"
Main Smoke Breeching
Boiler Smoke Connections.
℄ col 35 & 36
Girder 15"
Boiler No. 1
Boiler Furnaces
Burner
Hard Rock
Refractory Checker Floor
Set
Sat
Process in Pit Wall
Top of Boiler Pit
4" Concrete Curb
Secondary Air Pit
Footing col 35
Firing Pit Floor
Footing col 36
Boiler No. 2
Front of Boiler
Footing col 46
℄ col 45 & 46
First Floor
℄ col 55 & 56
Soffit of Concrete Arch
Present Floor Level of Incinerator Room & Work Shop
Footing col 45
Hard Rock
Footing col 55
Section Through Boiler & Boiler Pit
Section Through Work Shop

New York Air Conditioning Systems Must Have Water Saving Equipment

NEW rules and regulations governing and restricting the use of water for air conditioning and refrigerating in New York City have been established by Joseph Goodman, commissioner of the department of water supply, gas and electricity. They became effective on April 1, 1940 (superseding the former rule No. 42), and promote very greatly the use of cooling towers and evaporative condensers on New York air conditioning installations. Existing installations must comply not later than April 1, 1942.

The rules and regulations are as follows:

Refrigeration and Air Conditioning

Rule 42. No new installation of refrigerating or air conditioning equipment requiring the use of water shall be installed on any premises supplied from the municipal system until a permit authorizing such installation has been issued by the department.

Applications for permits shall specify the make, type and tonnage of installation, the minimum and maximum water requirements and such additional information regarding the proposed installation as may be required by the department.

Where the minimum rate of water required for the operation of the apparatus exceeds ½ gpm, the supply shall be metered.

Where the minimum rate does not exceed ½ gpm of water, the supply shall be metered or charged for on an annual rate basis subject to the discretion of the department.

Air Conditioning

*Rule 42A. No individual or collective air conditioning system installed on any premises for a single consumer shall be permitted to discharge to waste more than the equivalent of 5 gpm of city water annually, = 2,628,000 gal.**

All individual or collective air conditioning systems installed on any premises for a single consumer using in excess of the equivalent of 5 gpm of city water annually shall be equipped with a water conserving device such as economizer, evaporative condenser, water cooling tower or other similar apparatus, which device shall not consume for make-up purposes in excess of 15 per cent of the consumption that would normally be used without such device.

Any individual or collective group of such units installed on any premises for a single consumer with a rated capacity of 25 tons or more, or water consumption of 50 gpm or more, shall be equipped with a water meter to separately register the consumption of such units or groups of units.

This rule shall also apply to all air conditioning equipment now in service and such installations affected shall be equipped to conform with this rule by not later than April 1, 1942.

Use of Water Restricted

Rule 42B. The use of the pressure or flow of water from the city system as a source of energy is prohibited except when specifically approved by the department.

The use of water is permitted subject to such conditions or reservations as the department may consider reasonable.

The department reserves the right to restrict or prohibit extraordinary use of water if water supply conditions so require.

Rule 42C. The waste of water is prohibited. Violation of this rule is subject to penalties prescribed in Section 734 (4)-4.0 of the Administrative Code of the City of New York.

The above rules and regulations are effective as of April 1, 1940 and supersede present rule No. 42.

*A comfort air conditioning installation of less than 35 tons, say, operating under normal conditions, would therefore not be affected by the new regulations. If the equipment were operated 24 hr per day, the regulations might apply to, say, a 10 ton installation.—Ed.

Summary of

New York Air Conditioning Systems Must Have Water Saving Equipment

The commissioner of the department of water supply, gas and electricity of New York City established on April 1 new rules and regulations for the use of water for air conditioning and refrigerating. Existing installations must comply not later than April 1, 1942. . . . Where the minimum rate of water required exceeds ½ gpm, the supply must be metered. . . . No system is permitted to discharge to waste more than the equivalent of 5 gpm of city water annually; where the use is in excess of this, the system must have a water conserving device, such as an economizer, evaporative condenser or water cooling tower. . . . Use of the pressure or flow of water from the city system as a source of energy is prohibited unless approved, as is the waste of water

Air Conditioning Sold at Auction

Marking what is believed to be the first time an air conditioning system has been sold at public auction, equipment of the Great Northern Hotel, which is being demolished in Chicago, recently brought $1,700 under the auctioneer's hammer. The equipment, installed in 1935, was purchased by the Standard Club of Chicago, exclusive Jewish club in the midwest.

When the furnishings and fixtures of the hotel were offered for sale at public auction, prospective buyers found refrigeration machines, air conditioning units, outlets and controls.

How to Choose Economical Fuel for Heating Boilers

By Paul R. Unger*

SOUND engineering is playing an increasingly important part in the selection and application of equipment for firing heating boilers. Yet much equipment is bought and installed which is not of the type most suitable to its particular application. There is no question but that coal, oil or gas are all excellent fuels for combustion in the making of steam or that with adequate planning each of these fuels can yield high efficiencies. No generalization can be made as to the proper fuel to be burned in any one boiler plant in a given locality. Each should be individually analyzed.

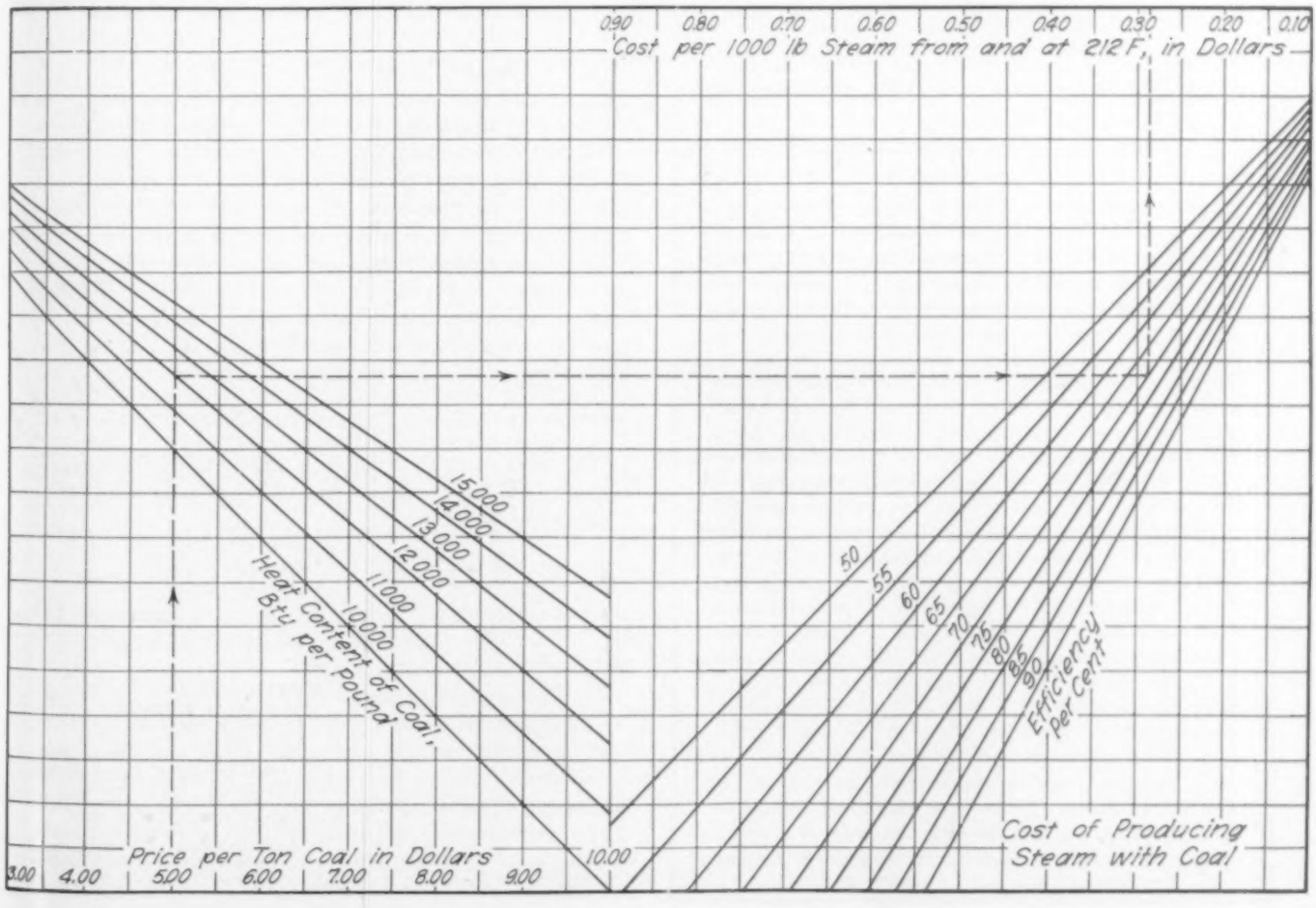
A primary consideration in such an analysis is of course the comparative cost of the various available fuels per 1000 lb of steam generated. For convenience in determining these costs, the accompanying charts have been prepared. The dotted lines indicate the method of using the charts.

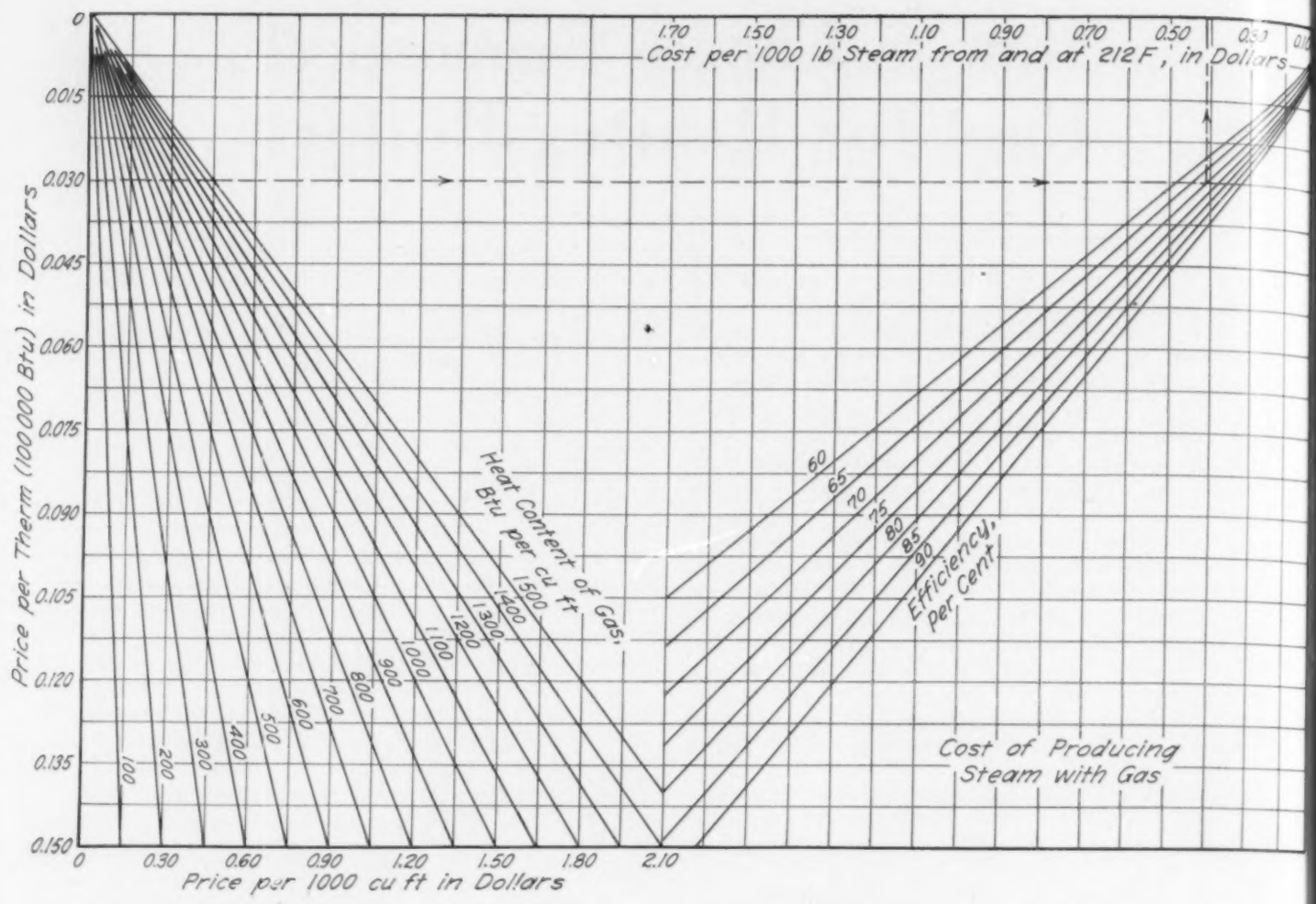
It is essential in making an analysis of fuel costs that existing conditions, such as cost of fuel, its heat content and the efficiency, be ascertained. Often in small plants the only available testing equipment is a portable flue gas analyzer and stack thermometer from which efficiencies can be only roughly approximated but from which comparative results with different fuels and equipment can be fairly accurately predetermined. In the larger plants it is definitely worthwhile to study present costs accurately even if it involves the expenditure of several hundred dollars. A competent, unbiased consulting engineer should be retained for this purpose, although many plants, of course, are equipped with the necessary means for measuring fuel feed and steam output and have personnel competent to make their own analyses.

The annual fuel cost may be readily calculated if the amount of steam used per year is known and if we are sure that the efficiencies we have assumed or demonstrated take into account all of the deviations from the norm which beset a steam plant during the course of the year, such as the cost of banked fires during week ends or holidays, sooty flues, lack of adjustment of control

*Mid-West Heat Service Co.

Copyright, 1940, by Paul R. Unger.





Summary of
How to Choose Economical Fuel for Heating Boilers
By Paul R. Unger

Sound engineering is playing an increasingly important part in selection of fuels for firing boilers. Coal, oil and gas are all excellent fuels and can be burned with high efficiencies with proper planning. It is impossible to generalize about the proper fuel for any one boiler plant in a given locality; each case should be individually analyzed. . . . . A primary consideration in such an analysis is the comparative cost of the various available fuels per 1000 lb of steam generated; the charts published here have been prepared to simplify determination of these costs. It is essential in making a fuel cost analysis to know the existing conditions; the plants that do not have their own instruments and personnel for doing this should retain a competent consulting engineer. It is also important that the assumed efficiencies take into account all of the deviations from the norm which beset a plant during the year, such as cost of banked fires, sooty flues, lack of adjustment of control systems, variations in fuel, etc. . . . . Costs other than those for fuel affect the problem, and some of these are suggested. With automatic firing, for example, it may be possible to release part of the operator's time for other duties. . . . . Flexibility should not be overlooked. Where the firing equipment can change its firing rate rapidly in response to changes in the load, the actual amount of steam used will be less. In many localities it is of advantage to be able to change from one fuel to another

systems and variations in fuels as to Btu, viscosity, ash content and moisture. If a plant is equipped with a good combustion control system and also with a complement of recording instruments, efficiencies can usually be maintained because changes in results will be immediately apparent and proper corrections made. It is the plant which cannot afford—or whose owners and operators think it cannot afford—proper recording, indicating and control equipment which usually finds it difficult to maintain the efficiencies originally planned. This is true regardless of the kind of fuel.

Costs Other Than Fuel

The next thing to consider is the cost of burning fuel, outside of the fuel cost. The following tabulation illustrates some of them:

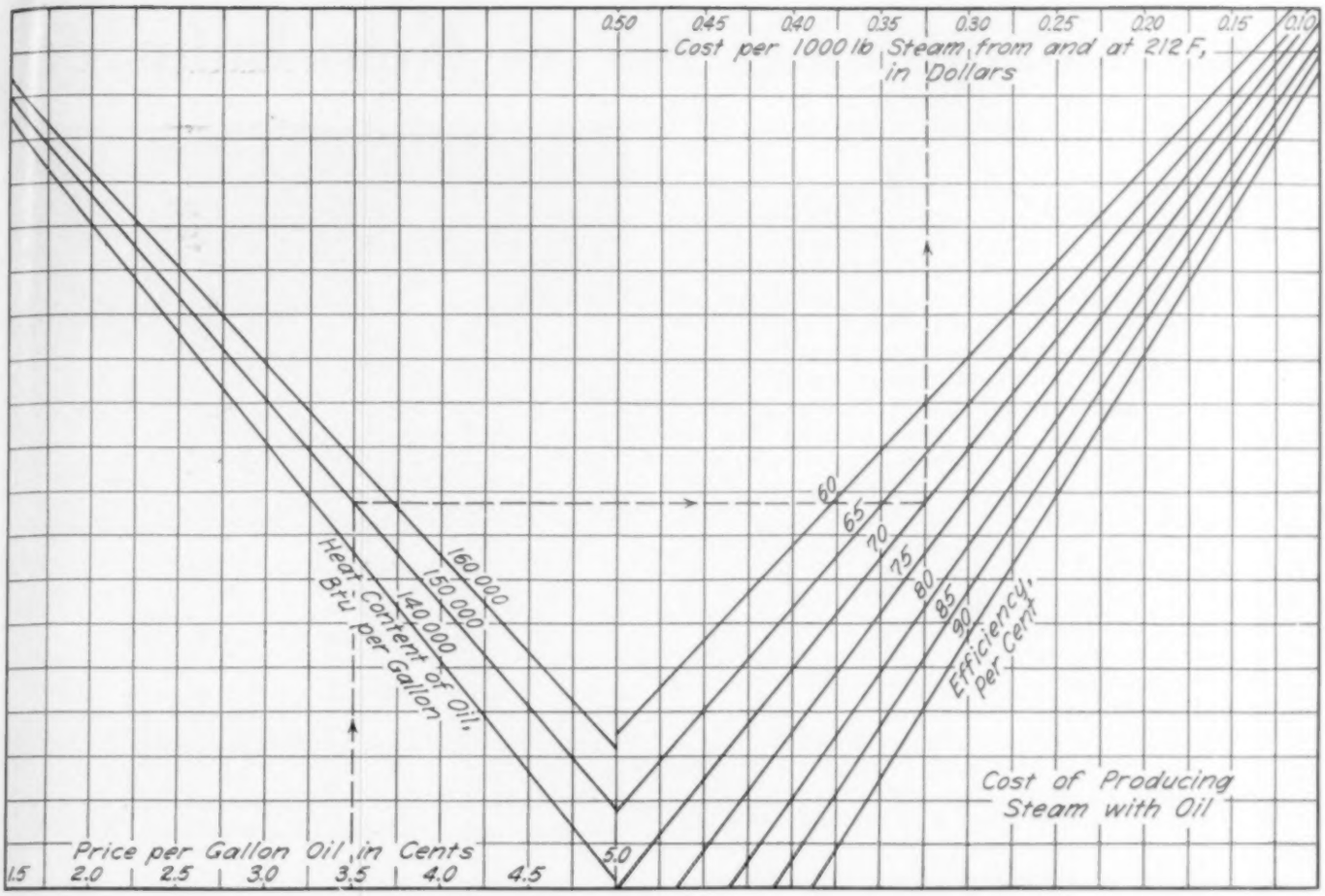
LABOR:
- Engineer's labor costs
- Firemen
- Coal passer
- Ash handler
- Cost of unloading

POWER:
- Ash hoists
- Coal handling (Conveyors, etc.)
- Unloading
- Oil pumping
- Forced draft fans
- Motors
- Gas boosters

STEAM CONSUMPTION:
- Stoker mechanism
- Blowers
- Heating oil
  1) Coils in tanks
  2) Booster oil heaters at boilers

MAINTENANCE:
- Brickwork
- Oil burner mechanism
- Gas burner mechanism
- Stoker parts, grates and dead plates
- Painting and decorating

MISCELLANEOUS:
- First cost of equipment
- Interest on investment
- Depreciation
- Cost of fuel storage space which might be released for other uses, per year
- Cost of maintaining banked fires when steam is not required
- Increased steam output that may become possible with the same boilers with a change in method of firing



With many plants it is also possible with automatic firing to release portions of the engineer's time for other duties. This does not necessarily mean that the engineer in a high pressure boiler plant must leave the boiler room. Frequently the machine shop or other general repair or maintenance work can be situated in the boiler room so that the engineer can be partly released for other duties and still be on hand to take care of any boiler problems which may arise.

Flexibility Is Worth Money

There is also the matter of flexibility of operation which may result in a direct fuel saving not indicated by the ratio of fuel costs per 1000 lb of steam. In a boiler plant in which the fuel burning equipment can change its firing rate rapidly in response to changes in load demand, the actual amount of steam used would be less than in a plant which was sluggish.

We have so far tackled this problem from the angle of the plant desiring to select the most efficient fuel and equipment for its needs. It is entirely possible (and in certain parts of the United States, extremely advantageous) to use more than one fuel in the same boiler room. In the middle west, for example, the gas companies offer low rates per therm for gas used during the offpeak seasons of the year. Gas can be purchased in some places from April 1 to November 1 for as low as 1.8c per therm. This may make it advisable to consider the possibility of using a combination of equipment to burn gas in the summer and oil or coal in the winter.

Another factor which enters into the selection of fuel equipment is the stability or instability of the fuel market. In many markets there are alternate periods in which liquid fuel becomes lower and then higher than coal. The modern plant, if it is to take advantage of the lowest fuel costs year in and year out, and if it is in a locality where the shift in fuel prices makes one fuel alternately higher or lower than another, should be designed to carry all or the bulk of the load on whichever fuel is currently cheapest. This is not as complicated as it sounds. The writer has installed many plants using combination oil and gas burners firing over existing stokers arranged so that a change from oil to gas might be made instantly and a change from oil or gas to coal in 24 hr. If the combination equipment is designed to use pulverized coal, oil or gas, an even more rapid change may be made from liquid to solid fuel. Another and important advantage in equipping a plant to burn any fuel is the protection it affords against strikes or other tie-ups affecting one or another type of fuel.

Steel Mill Cleans Air Electrically

First steel mill installation of electrostatic air cleaning apparatus for purifying ventilating air for main drives and motor generator sets is being made at the Weirton Steel Co., Weirton, W. Va.

The system consists of two units, each rated at 72,000 cfm and involving 120 36 in. cells grouped four high by 30 wide. One smaller unit is rated at 45,000 cfm, and is made up of 76 36 in. cells four high by 19 wide.

Air Conditioning Serves New Industry

By A. T. Spangler* and Fred Pederson†

SEVENTEEN years ago an engineer returning from South America brought 11 live chinchillas into California wrapped in towels and blankets and warmed by hot water bottles. The sudden change in climate had caused them to lose all of their valuable fur. That 1923 event started a new—and air conditioned—American industry, the raising of chinchillas.

Of the 3500 animals to which the original group of 11 has grown, approximately 2000 are at the home chinchilla ranch at Englewood, Calif. The remaining 1500 are scattered throughout the country at private ranches—one of these is operated by R. A. Graef at Laurys, Pa.

The native habitat of the chinchilla is in the Andes mountains, a region whose climatic conditions can best be described as arid. For that reason a low relative humidity is essential for the proper growth and development of these animals. Temperature conditions, of course, are equally important. The chinchilla develops a heavier coat during the winter season. The provision of proper humidity and temperature conditions at the Graef ranch therefore became a prime consideration.

For best results, the conditions to be maintained in the stable during the summer season are preferably 70 F dry bulb with a relative humidity of 30 per cent. During the winter an inside temperature of 40 F is advisable. In order to hold the initial installation cost and final operating cost to a minimum, it was decided to use equipment capable of maintaining the designed summer conditions during 90 per cent of the summer operating period. For the remaining time during which extreme peak conditions may exist, the temperature is allowed to build up to a maximum of 78 F with a relative humidity of 40 per cent.

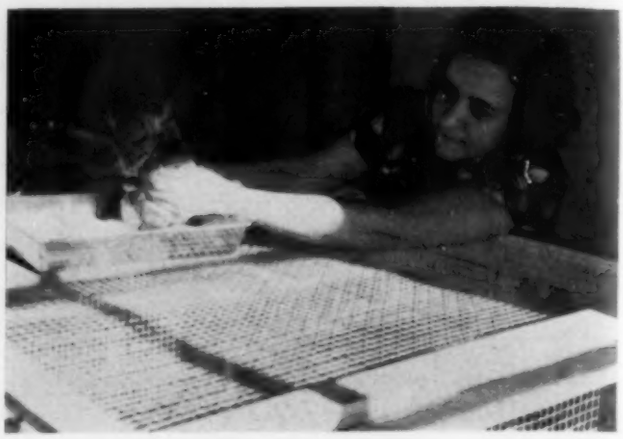
*Hardner Engrg. Co.
†Trane Co.

Summary of

Air Conditioning Serves New Industry

By A. T. Spangler and Fred Pederson

Air conditioning is serving a new industry—the growing of chinchillas in the United States. For best results—to protect the health and well-being of the animals and their precious fur—controlled temperatures and humidities are necessary. At a Pennsylvania chinchilla ranch, design summer conditions are 70 F dry bulb and 30 per cent relative humidity, and during winter 40 F inside temperature is advisable . . . . . Here are some interesting facts about chinchillas: (1) Their natural habitat is the high Andes mountain region in South America. . . . (2) Chinchillas are strictly monogamous. (3) Chinchillas mate at about the age of six months. Before they are a year old they usually have produced their first litter. The average pair produces from one to four animals per litter—and may have two or even three litters per year. . . . (4) Little chinchillas are born fully developed in every respect and are able to walk about within a very few minutes after birth. . . . (5) Fully grown chinchillas weigh from 16 to 18 ounces and they live eight to 10 years. . . . (6) Approximately 150 to 200 pelts are required to make a chinchilla coat. As many as 2,000 pelts may be necessary to obtain 200 well matched ones. . . . (7) A pair of chinchillas costs $3,200. . . . (8) Chinchillas require but little water—prefer mineral spring water for drinking. . . . (9) The sale price of a short wrap or jacket will be around $30,000 with a full length chinchilla coat selling at $75,000. . . . (10) Ranch-grown chinchillas require a special diet of processed food composed of the following—yeast, molasses, wheat, oat middlings, beet pulp, peanut and soy bean oil meal, corn meal, bone meal and mineralized salts



The chinchillas are kept in cages

The building measures 78 x 12 ft and has an 8 ft ceiling height, and is insulated. The animals are kept in 64 cages.

The air conditioning equipment takes the form of a unit using a two row hot water heating coil and a six row direct expansion cooling coil. This unit delivers a total of 1200 cfm of conditioned air of which 25 per cent is outside air. During the heating season the hot water is supplied from an oil burning boiler in a neighboring garage. Forced circulation is used, and the pump and piping were sized and planned with an eye to the future to take care of three additional buildings similar to the first one. The air conditioning unit is suspended from the ceiling of the machinery room, and the conditioned air is supplied through a duct running across the width of the stable.

Two 3 hp air cooled compressors interconnected with oil level and gas pressure equalizer lines function during the summer. These machines are mounted on a concrete foundation in a space that can be closed off by removable panels. They are supplied with outside air through a large louver and screen in the outside wall. These two air cooled compressors were selected rather than one 5 or 7½ hp single water cooled compressor because there is no water supply at or near the building.

The two compressors are operated by a two step thermostat and a humidistat. The first stage of the thermostat controls a liquid solenoid valve and, through the pressurestat, governs the operation of the first machine. The second machine is operated either by the second stage of the thermostat or by the humidistat. A separate thermostat controls the heating cycle and by setting the two thermostats within a few degrees of one another and then gradually changing the settings of both, it is possible to gradually taper off from one season condition to another.

Corrosion in Steam Heating Systems

Feedwater Treating System in Central Heating Plant

By Leo F. Collins* with Everette L. Henderson†

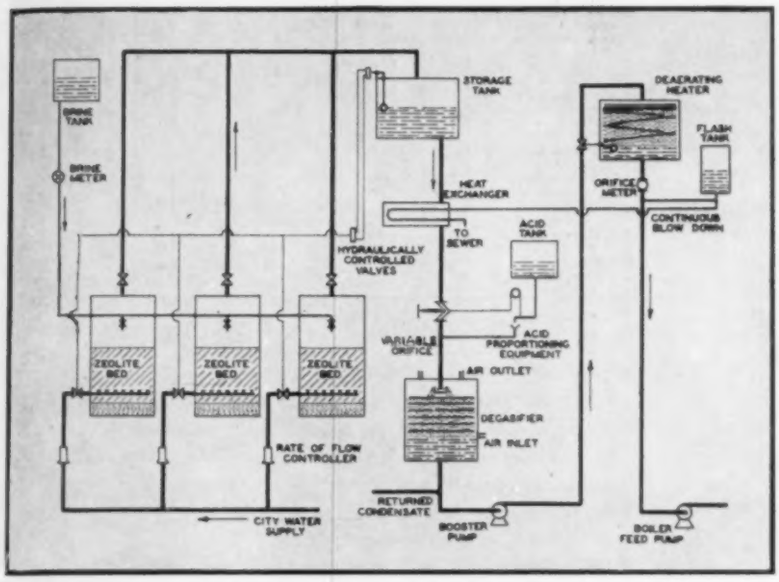


Fig. 33—The new feedwater cycle

THE feedwater treating system under consideration is in use at the Congress St. heating plant of The Detroit Edison Co., which plant produces annually about 725,000,000 lb of steam. The old feedwater cycle at this plant and the development and details of the new cycle were described in the preceding installment of this series published last month. The new feedwater cycle is shown diagrammatically in Fig. 33 (which is the same as Fig. 28 published last month but is reproduced again for convenient reference.)

Operation of the System

Make-up water under city water pressure is forced through the upflow green sand zeolite softeners at a constant rate as governed by venturi type rate-of-flow controllers. It discharges to the storage tank wherein is situated a float control mechanism which triggers the shut-off valves on the influent lines to the softeners.

From the storage tank water flows by gravity to the degasifier as dictated by the plant load requirements. The latter is reflected by the level of a float in the storage space of the degasifier which operates a multiport sleeve valve with adjustable ports in the degasifier influent line.**

Water flowing through the adjustable orifice creates a differential pressure which raises or lowers the acid orifice, thus feeding acid in direct proportioning to the amount of water passing. A constant amount of air, about 4800 cfm, is forced through the degasifier regardless of the amount of water entering. Likewise, the acid pumps supply considerably more acid to the constant level tank than is required to satisfy the acid orifice. The excess acid, however, returns by gravity to the dilute acid tank. There is some benefit in the constant mixing thus provided.

The degasifier effluent is picked up by the heater supply pumps and introduced into the deaerator. The pumps are automatically regulated to maintain a constant pressure in the heater supply line. The quantity of water admitted to the heater is determined by the water level in the storage space of the heater.

*Chemist, The Detroit Edison Co.
†Professor of Chemistry, University of Detroit.

Part 9. Part 1 was published in HEATING, PIPING AND AIR CONDITIONING, September, 1939, pp. 539-542; Part 2 in October, pp. 620-622; Part 3 in November, pp. 675-677; Part 4 in December, pp. 735-738; Part 5 in January, 1940, pp. 24-27; Part 6 in February, pp. 99-101; Part 7 in March, pp. 159-162; and Part 8 in April, pp. 243-246.

**A second float controlled valve is also provided to admit water without acid treatment, directly to the degasifier if any emergency should arise in which the feedwater demand is in excess of that which can pass through the multiport sleeve valve at the prevailing setting.

Summary of
Corrosion in Steam Heating Systems
By Leo F. Collins with Everette L. Henderson

The earlier sections of this series dealt with the aspects of the problem of corrosion in steam heating systems in two general ways. Those expedients which provide more or less temporary relief were considered and later the possibilities of eliminating the basic causes and thus effecting a permanent remedy were reviewed. . . . . It is evident from the data which have been published that the most comprehensive expedient which can be adopted, especially by district heating companies, is a reduction of the deleterious gas content of the steam. This, as a usual thing, will involve very exact control of the boiler feedwater treatment. Moreover, some of the benefit which should accrue will be lost if the heating systems served are not carefully designed, well maintained, and properly operated. . . . . It is hoped that those considering the feasibility of CO_2 removal will obtain, from the experimental data presented, an appreciation of some of the complexities involved. Then, too, it will be well to remember that this phase of water treatment is so new that little experience has yet been obtained. For this reason the claims made for certain schemes are sometimes based only upon deductions. Thus, those charged with such a development should at least have a sufficient technical background to judge whether or not the schemes proposed are inherently capable of giving the results predicted. . . . . The section of this paper published last month described in detail a water treating scheme that has been developed in a large central heating plant to produce a steam containing not more than 5 ppm [parts per million] of CO_2 and no oxygen. The operation, control and experience with the new method are discussed this month. Although the treating costs are high, the authors feel that the benefits of chemically pure steam should more than compensate the expense

The heater effluent flows by gravity to the boilerfeed pumps. These force the water into the purifiers (a carryover from a former feedwater treating scheme) from which it flows by gravity into the boilers.

The boilers are blown down continuously through a heat exchanger to maintain the concentration in the boiler water below a predetermined value. A multiple point conductivity meter provides a continuous record for such regulation. The blow off valves are hand operated.

Since the feedwater is almost completely neutralized with sulphuric acid and since one of the operating indices in use at this plant is to maintain the sulphate

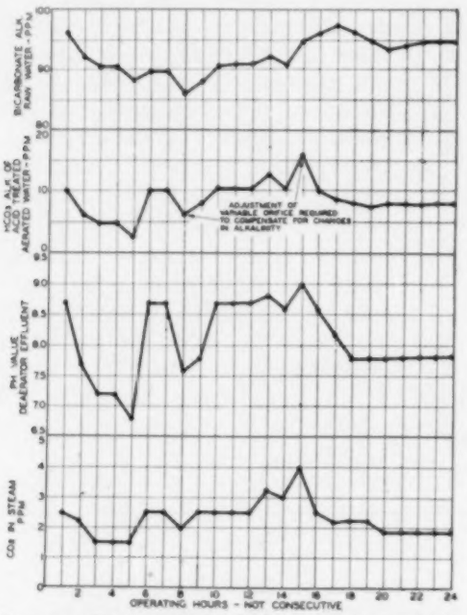

BICARBONATE ALK. RAW WATER - P.P.M.
HCO3 ALK. OF ACID TREATED WATER - P.P.M.
ADJUSTMENT OF WASHABLE ORIFICE REQUIRED TO COMPENSATE FOR CHANGES IN ALKALINITY
PH VALUE DEAERATOR EFFLUENT
CO2 IN STEAM P.P.M.
OPERATING HOURS - NOT CONSECUTIVE

Fig. 34—Data typical of the variations which normally occur at key points of feedwater cycle

(SO_4) concentration of the boiler water below 1000 ppm (parts per million), it is obvious that the percentage blowdown is higher than with the old system. It was anticipated that this would reduce the alkalinity of the boiler water to such an extent that serious corrosion of the boilers might eventuate. For this reason enough caustic soda is added periodically to maintain the alkalinity of the boiler water within a range believed to prohibit serious corrosion under the prevailing conditions.

Control of the System

While the system has been made as nearly automatic as now seems feasible, there are nevertheless several operations which must be carried out manually. These include the mixing of acid and brine solutions, regeneration of the zeolite softeners, determinations of the alkalinity of the water, both before and after addition of the acid, adjustment of the acid proportioning device (which includes also the adjustable orifice), analyses of the boiler water, and the feeding of caustic soda to the boilers. These are all performed by the plant's personnel under the supervision of a chemist. No additional men have been added but it is felt that to insure success for such a system operators of better than average intelligence and an experienced feedwater chemist are prerequisites.

Table 16—Conditions at Key Points in Feedwater Cycle
(All figures are parts per million except pH values)

	Make-up Water		Average Conditions With New System					
	Raw	Zeolite Softened	After Adding Acid (Degasifier Influent)	Degasifier Effluent	To Deaerator[a]	Leaving Deaerator	In Boilers	Steam
Silica, SiO_2	1	4	4	4	3	3	20	—
Oxides, Fe_2O_3 & Al_2O_3	1	2	2	2	1	1	12	—
Calcium, Ca	25	1	1	1	1	1	2	—
Magnesium, Mg	6	0.2	0.2	0.2	0.2	0.2	1	—
Sodium & K (as Na)	5	48	48	48	43	43	600	—
Bicarbonate, HCO_3	98	98	10	10	7	6	70	—
Carbonate, CO_3	0	0	0	0	0	1	10	—
Hydrate, OH	0	0	0	0	0	0	100	—
Phosphate, PO_4	0	0	4	4	3	3	30	—
Sulphate, SO_4	21	21	86	86	79	79	1000	—
Chloride, Cl	6	6	6	6	5	5	100	—
Dissolved Solids	120	130	170	170	153	153	2000	2.5
Hardness as $CaCO_3$	89	3	3	3	2	2	9	—
Oxygen, O_2	13	13	13	13	13	0	0	0
CO_2 (Free)	2	2	50	10	10	0	0	3
pH Value[b]	7.1	7.9	5.2	6.4	6.4	8.0	11.6	6.0
Temperature, F	40	40	40	50	80	220	356	356
Pressure, lb per sq in.	55	—	—	—	—	2.5	130	130

[a] Contains about 25 per cent returned condensate.
[b] All pH values were measured at room temperature.

While no additional men have been added, the duties of certain operators have been expanded. In addition to the duties previously performed, those in control of the present scheme of operation, particularly the shift engineers, are now required to assume the following additional duties over a normal 24 hr period:

1) Readjust the adjustable orifice.
2) Change acid orifices about 10 times.
3) Determine the alkalinity of the raw water at least once each 8 hr shift.
4) Determine the alkalinity of the acid treated water once each hour.

A recorder using a glass electrode measures the pH of the acid treated water as it falls into the storage space of the degasifier. Insofar as operation is concerned, this can be relied upon to show only the presence of free mineral acid. Under the conditions prevailing pH measurements cannot be made to show directly the bicarbonate ion concentration. Such a recorder therefore is a valuable adjunct to a manual titration, since it provides a continuous record, but it cannot be used in lieu thereof.

Operating Experiences and Results

The average conditions which prevail at various points throughout the cycle are shown in Table 16 and Fig. 34 shows some hourly variations which occur at key points.

Fig. 35—Comparative corrosiveness of steam developed in same plant but containing different CO_2 contents

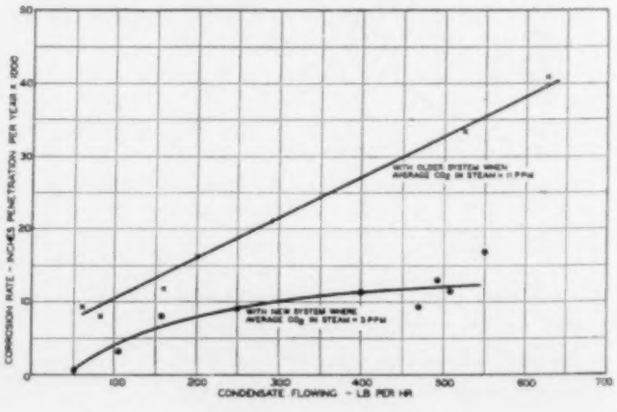

CORROSION RATE - INCHES PENETRATION PER YEAR x 1000
WITH OLDER SYSTEM WHEN AVERAGE CO2 IN STEAM = 17 P.P.M.
WITH NEW SYSTEM WHERE AVERAGE CO2 IN STEAM = 3 P.P.M.
CONDENSATE FLOWING - LB PER HR

Fig. 35 shows the comparative corrosiveness of the steam developed with the old and new systems. (The data of Table 16 were also included in Table 15, published last month.—Ed.)

Tests conducted upon the degasifier indicate that excess air is being used. The curves in Fig. 36 show the relation found between residual CO_2 and the air-water ratio. The effects of water temperatures between 49 and 67 F are shown in Fig. 37. The data in Fig. 36 indicate that air in excess of 10 cfm per 1000 lb per hr of

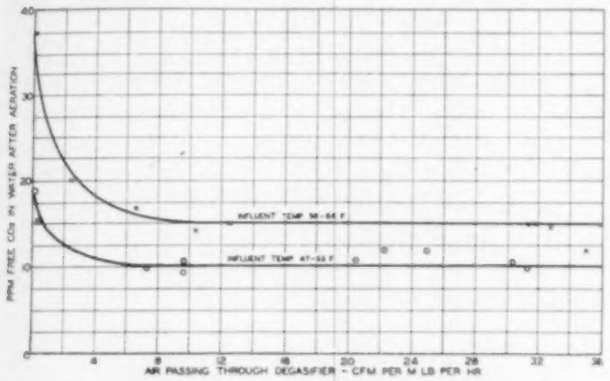

PPM FREE CO2 IN WATER AFTER AERATION
INFLUENT TEMP 50-64 F
INFLUENT TEMP 47-53 F
AIR PASSING THROUGH DEGASIFIER - CFM PER M LB PER HR

Fig. 36—Effect of quantity of air passed through degasifier on the free CO_2 in the water after aeration

water is of little or no value. This is of little significance, however, since the added costs for electrical energy are not important. It is also clear that high temperatures are conducive to good CO_2 removal but under the conditions which prevail, preheating of the water would be impractical.

Measurements made with National District Heating Association testers indicate the rate of corrosion in the water line between the degasifier and feedwater heater is about 16. Since part of this line is lead lined and the pH value of the water is comparable with that which persisted heretofore, troubles from this source are not anticipated. A careful inspection of the piping and boilers after the first year of operation indicates that corrosion has not been accentuated by the new method of treatment.

The operating costs of most feedwater treating systems are usually of two kinds; those which are fixed regardless of the amount of water treated and those which vary almost in proportion to the amount of water treated. The attendant labor, for example, is in the former class, while chemical costs are in the latter. Capital charges and maintenance expense, while obviously a part of the overall costs, cannot well be included. The "standards" maintained vary so widely that when comparisons are made between plants erroneous conclusions are sometimes drawn. In the present case these could not be included for at least two reasons: (a) the system is relatively new and has therefore required little maintenance; (b) it was designed largely as an experiment and economy was probably not given the consideration it normally would receive.

These features should be kept in mind when consulting Table 17 and when comparing these data with those for any other system.

The cost of treatment with the new system is considerably higher than with the old system. With respect to labor costs, the man-hours required to control the more exacting system necessarily increased. Since no additional men were added, however, this did not increase the overall plant operating costs. The unit costs of salt and wash water were higher than formerly, while the cost of phosphoric acid was considerably lower. These facts should be kept in mind when reviewing these data. It is also clear the costs would be considerably lower if the plant load were higher and more continuous.

Table 17—Comparative Annual Operating Costs (in Dollars) of Feedwater Treatment

	Old System[b]	New System[d]
Costs which are fixed regardless of amount of water treated:		
Labora	966	1318
Miscellaneous	30c	15c
Costs which vary with the amount of water treated:		
Salt	1059	1069
Sulphuric acid	530	841
Phosphoric acid (75%)	472	215
Caustic soda (flake)	None	451
Wash water	150	228
Water treated, 1000 lb	666,376	476,000
Total cost per 1000 lb	$0.0048	$0.0087

[a] Does not include time of supervising chemist.
[b] Average for heating seasons 1931-32, 1932-33, 1933-34.
[c] Estimated—mostly laboratory supplies.
[d] Data cover September 1, 1938, to April 30, 1939, inclusive.
Note: Following are the lb of chemicals used per 1000 lb of water. Old system—salt, 0.64; sulphuric acid, 0.039; phosphoric acid, 0.006; wash water, 55. New system—salt, 0.64; sulphuric acid, 0.077; phosphoric acid, 0.006; caustic soda, 0.028; wash water, 55.

Conclusions

Since experience with the new feedwater treatment method is limited to only one season of operation the conclusions drawn must be conservative. It is felt, however, that unless some serious operating difficulty eventuates, the practicability of the scheme will have been established. While careful and intelligent supervision is required, this would be true of any system designed to meet the exacting requirements that are now considered desirable.

Although the treating costs are high it is felt the benefits which should accrue from the use of a steam which is as pure chemically as modern science knows how to produce (commercially) will more than compensate for the additional operating expense.

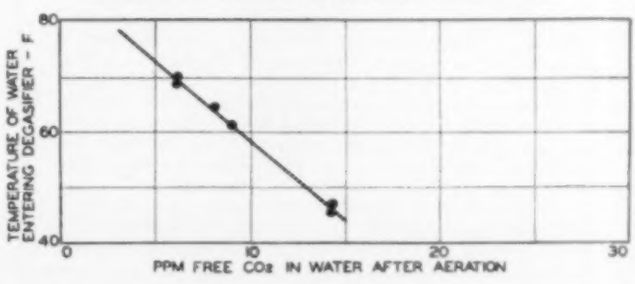
While space precludes the possibility of enumerating all those who, in one way or another, collaborated in these studies, the authors wish to acknowledge, nevertheless, the coöperation so generously given. An exception is J. H. Walker of The Detroit Edison Co. whose most capable counsel has been of inestimable value.

[*Concluded*]

Supplementary Bibliography on Corrosion

1. *Power*, Cause and Control of Corrosion in Boiler Plants and Heating Systems, Vol. 60, p. 71, July 8, 1924.
2. *Power Plant Engineering*, Prevention of Corrosion in Pipes, Vol. 26, pp. 119-120, January 15, 1922.

Fig. 37—Relationship between water temperature and "free" CO_2 content of aerated water



5. Report from Landesanstalt fuer-Boden-und Lufthygiene summarizing observations on corrosion in low pressure steam heating plants.
4. W. J. Baldwin, Jr., Pipe Corrosion, *National District Heating Association Bulletin*, Vol. 17, January 15, 1932. Discusses steam pipe layouts where corrosion is likely to occur; practical review of proper methods of design and installation.
5. G. L. Cox, and B. E. Roetheli, Effect of Oxygen Concentration on Corrosion Rates of Steel and Composition of Corrosion Products Formed in Oxygenated Water, *Industrial and Engineering Chemistry*, Vol. 23, No. 9, September, 1931.
6. U. R. Evans, Oxygen Distribution as a Factor in the Corrosion of Metals, *Industrial and Engineering Chemistry*, Vol. 17, No. 4, 1925.
7. U. R. Evans, The Influence of Acids in Passivity and Corrosion, *Journal Chemical Society*, March, 1930, pp. 278-92.
8. H. O. Forrest, B. E. Roetheli, and R. H. Brown, The Initial Corrosion Rate of Steel, *Industrial and Engineering Chemistry*, Vol. 22, No. 11, November, 1930.
9. H. O. Forrest, B. E. Roetheli and R. H. Brown, Products of Corrosion of Steel, Factors Determining Their Composition and Its Influence on Rate of Corrosion in Oxygenated Water, *Industrial and Engineering Chemistry*, Vol. 22, No. 6, 1931.
10. R. E. Hall, and A. R. Mumford, Some Fundamental Considerations of Corrosion in Steam and Condensate Lines, ASHVE *Journal Section*, HEATING, PIPING AND AIR CONDITIONING, Vol. 3, November and December, 1931, pp. 943-959 and pp. 1041-1049.
11. J. F. G. Hicks, Observations on the Corrosion of Iron, *J. Phys Chem.*, 33, pp. 780-90, 1929.
12. F. Ingham, Internal Corrosion of Fuel Economizers, *Mechanical World*, Vol. 82, p. 467, December 23, 1927. Discusses corrosion of cast iron in water containing oxygen and carbon dioxide; corrosion can be prevented by eliminating all dissolved gases.
13. C. E. Joos and V. A. Rohlin, Combating Corrosion of Piping, HEATING, PIPING AND AIR CONDITIONING, Vol. 4, pp. 533-537, 606-607, 671-674, August, September and October, 1932.
14. D. H. Jackson, and J. R. McDermet, Effect of Deaeration of Natural Waters on the Carbonate Equilibrium, *Journal of Industrial and Engineering Chemistry*, 15, pp. 959-61, 1923.
15. W. B. Lewis and C. S. Irving, Differential Aeration Corrosion Theory, *Eng. and Boiler House Rev.*, Vol. 40, pp. 583-584, May, 1927.
16. J. R. McDermet, Corrosion and Its Prevention in Vessels Carrying Water, *Journal American Society of Heating and Ventilating Engineers*, Vol. 28, pp. 407-416, May, 1922.
17. J. R. McDermet, Deaeration of Water in Relation to Character of Water Supply, *Journal of American Water Works Association*, 21, 1339-44, 1929.
18. H. N. McCoy, Equilibrium in the System Composed of Sodium Carbonate, Sodium Bicarbonate, Carbon Dioxide, and Water, *University of Chicago*, The Decennial Publication, Vol. 9, 1903.
19. E. Naumann, Beobachtungen ueber Korrosionen in Niederdruckdampfheizungsanlagen, *Gesundheits-Ingenieur*, Vol. 56, No. 27, July 8, 1933.
20. G. W. Nigh, Causes and Prevention of Corrosion in Heating Boilers, *Heating and Ventilating*, Vol. 28, pp. 36-40, November, 1931.
21. B. E. Roetheli, and R. H. Brown, Corrosion Rates, of Steel and Composition of Corrosion Products Formed in Oxygenated Water as Affected by Velocity, *Industrial and Engineering Chemistry*, Vol. 23, No. 9, September, 1931.
22. R. Stumper, Korrosion und Metallschutz im Dampfkraftbetrieb, *VT. Korrosion u. Metallschutz*, Vol. 9, pp. 231-239, 1933.
23. E. B. Shinman, Return Line Corrosion, *Power Plant Engineering*, Vol. 36, June 15, 1932. Consideration of main causes of pipe line corrosion, most important of which is oxygen; deaeration of feedwater; live steam heating; large size, steep pitch and proper trapping essential; protecting return lines by feeding oil.
24. F. N. Speller, Corrosion, Causes and Prevention, *McGraw-Hill Book Co.*
25. J. W. Shipley, I. R. McHaffie, and N. D. Clare, Corrosion of Iron in the Absence of Oxygen, *Industrial and Engineering Chemistry*, Vol. 17, No. 4, April, 1925. Discusses and gives values for corrosion rates in aqueous solutions buffered at pH values between 5.0 and 10.0.
26. W. R. Whitney, Corrosion of Iron, *Journal American Chemical Society*, Vol. 25, pp. 394-406, 1903.
27. R. E. Wilson, Mechanism of the Corrosion of Iron and Steel in Natural Waters and the Calculation of Specific Rates of Corrosion. Summarizes the work of other investigators and analyzes the respective relations of the reactions governing corrosion. *Journal of Industrial and Engineering Chemistry*, Vol. 15, pp. 127-133, 1923.

New Features for World's Fair Air Conditioning Exhibit

By J. I. Lyle*

A "human furnace," atmosphere-testing canaries and a "cold dog stand" are among innovations in the "Weathermaker's Wonderland" exhibit at the 1940 New York World's Fair. Designed along popular lines, the exhibit will dramatize the workings of air conditioning by comparing the human body, the most efficient air conditioning machine ever devised, to man-made weather. The "human furnace," highlight of the exhibit, is a huge, glass enclosed heat chamber which will measure the amount of heat given off by the human body. A gage will record the human "heat wave."

Another feature of the exhibit, designed to show how dirt and foreign matter is filtered out of the air through air conditioning, will be a glass enclosed bird cage, divided into two sections separated by filters. Dirt and dust will be introduced into one section. This same air will be drawn through filters into the bird compartment, where, in the clean, pure air three English canaries will enjoy their stay at the fair.

The exhibits will be explained in an entertaining, 15 min lecture by air conditioning engineers. The entire interior of the "Igloo" was ripped out and made over for the new exhibits. The "Aurora Borealis," which played on the inside of the building's dome last year, will be flashed upon the exterior of the five story, cone shaped structure in 1940.

A foot cooler, or "cold dog stand," will be an innovation for foot-weary fairgoers when the exhibit opens on May 11, while a humidity fed fountain will be another newcomer.

A "moisture collector," showing how water is "wrung" from the air you breathe, will be another display portraying to the lay mind the functions of air conditioning. The total amount of moisture extracted from the air will be registered, hour by hour, on an indicator, which will also show the total moisture extracted from day to day at the "Igloo." Drops of water will be counted by the machine as they condense from the coils of the air conditioning system supplying the building with conditioned air.

The "refrigeration cycle," showing a cross-section of a refrigeration machine in action, will be another display.

At the over-sized "steam kettle," visitors will witness another interesting experiment showing the effect of changes of humidity on various materials. A blast of live steam is first permitted to pass through a chamber, which cools the steam but allows the moisture to pass through into a bell jar containing three materials particularly sensitive to humidity. The moisture makes these substances curl and twist. Then the steam is diverted through a chamber containing cooling coils similar to those used in air conditioning systems. The steam condenses rapidly and pours into a glass aquarium, in which tropical fish are swimming, and the dehumidified air passes over the materials, making them straighten out exactly as they were before the moisture hit them.

The exhibit attracted 2,729,909 guests last year.

*President, Carrier Corp.

Summary of
New Features for World's Fair
Air Conditioning Exhibit
By J. I. Lyle

When the New York World's Fair re-opens May 11, many new exhibits will be on display. In the "Weathermaker's Wonderland," for example, there will be a "human furnace" exhibit to measure the heat given off by the human body, a display of the effectiveness of filtering air, a foot cooler—or "cold dog stand"—for weary fairgoers, a moisture collector which will record the humidity removed from the air, a display explaining the refrigeration cycle, one showing the effect of moisture on hygroscopic materials, and many others. . . . . Wednesday morning, May 29, is to be "heating and air conditioning day" at the fair, and a session of the convention of the *Heating, Piping and Air Conditioning Contractors National Association* will be held on the fair grounds on that occasion

The Psychrometric Chart
Its Application and Theory

By William Goodman*

PUBLICATION of the text of this series on the psychrometric chart was completed last month; with this issue, we begin publication of the appendices, which show how the various equations presented in the text are derived.

Some of the tables of end points for wet bulb lines for various barometric pressures have already appeared; additional ones are presented this month and more will be given in later installments.

Appendix 1

Proof that Equation 4 of the Text is the Equation of a Straight Line on the Psychrometric Chart

Equation 4 of the text may be written

$$\frac{h - h_1}{w - w_1} = q \quad \ldots\ldots [1]$$

where h and w represent the final enthalpy and absolute humidity of the air leaving the conditioning chamber.

Equation 1 may be rewritten

$$h = qw - (qw_1 - h_1) \quad \ldots\ldots [2]$$

Inasmuch as h_1 and w_1 correspond to the initial state of the air, they are constant. Now if q is also constant, [2] above is evidently the equation of a straight line on a chart whose coördinates are the variables h and w. Consequently, all of the points representing the final state of the air must lie on a straight line.

Appendix 2

Derivation of Equation 7 of the Text

Equation 5 of the text is

$$q = \frac{Q}{W_o} + h_o \quad \ldots\ldots [1]$$

Equation 9 of the text is

$$q_s = \frac{Q - W_o (h_{g2} - h_o)}{Q + W_o h_o} \quad \ldots\ldots [2]$$

$$= \frac{\left(\frac{Q}{W_o} + h_o\right) - h_{g2}}{\left(\frac{Q}{W_o} + h_o\right)} \quad \ldots\ldots [3]$$

Substitute [1] into [3].

$$q_s = \frac{q - h_{g2}}{q}$$

$$q = \frac{h_{g2}}{1 - q_s} \quad \ldots\ldots [4]$$

This is equation 7 of the text. The approximate form of this equation is obtained as follows: As shown in the article New Tables of the Psychrometric Properties of Air-Vapor Mixtures, HEATING, PIPING AND AIR CONDITIONING, January-February, 1938,

$$h_{g2} = 1061 + 0.45t_2 \quad \ldots\ldots [5]$$

For moderate temperatures, the value of $0.45t$ is small compared to 1061 and may be neglected. When this is the case, the following approximate form of equation 4 may be used.

$$q = \frac{1061}{1 - q_s} \quad \ldots\ldots [6]$$

Appendix 3

Proof that Slight Change in Enthalpy Along a Line of Constant Wet Bulb Temperature is Equal to Enthalpy of the Liquid Added to the Air

In Fig. 34, 1-2 is a line of constant wet bulb temperature. Using equation 12 of the text

$$\frac{h_2 - h_1}{w_2 - w_1} = h_w \quad \ldots\ldots [1]$$

In this case, h_w is the enthalpy of water at a temperature equal to the wet bulb temperature for which line 1-2 is drawn.

But, referring to Fig. 34,

$$w_1 = 0 \quad \ldots\ldots [2]$$

Hence,

$$h_2 - h_1 = w_2 h_w \quad \ldots\ldots [3]$$

Therefore, the change in the enthalpy between points 2 and 1 is equal to the enthalpy of the liquid added to the air. This statement is true as long as the enthalpy of the

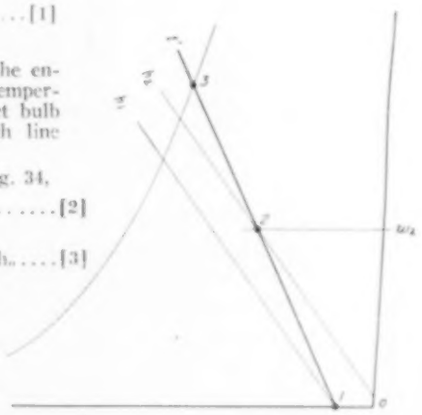


Fig. 34—Illustration showing change in enthalpy along a line of constant wet bulb temperature. Distances and angles between lines are exaggerated for clarity

Symbols Used

(For complete list, see p. 358, June, 1939, HPAC)

- h = enthalpy of air-vapor mixture, Btu per lb of dry air in the mixture
- h_g = enthalpy of moisture in vapor state, Btu per lb of vapor
- h_o = enthalpy of moisture in any state, Btu per lb of moisture
- Q = quantity of heat added to the air or removed from it, Btu per min
- q = moisture ratio, Btu per lb of moisture evaporated into the air or condensed from it
- q_D = moisture ratio for slope of a line of constant dry bulb temperature, Btu per lb of moisture
- q_s = sensible heat ratio. See equations 6 and 9 of the text
- t = dry bulb temperature, deg Fahr
- t' = wet bulb temperature, deg Fahr
- W_o = weight of moisture evaporated into the air or condensed from it, lb per min
- w = absolute humidity of the air-vapor mixture, lb of moisture per lb of dry air in the mixture

Subscript "1" refers to the initial state of the substance and subscript "2" refers to its final state.

---

*The Trane Co. Member of Board of Consulting and Contributing Editors.

Part 12. Part 1 was published in HEATING, PIPING AND AIR CONDITIONING, June, 1939, pp. 357-360; Part 2 in July, pp. 421-424; Part 3 in August, pp. 485-487; Part 4 in September, pp. 549-551; Part 5 in October, pp. 613-615 and p. 617; Part 6 in November, pp. 671-674; Part 7 in December, pp. 749-752; Part 8 in January, 1940, pp. 6-9; Part 9 in February, pp. 107-110; Part 10 in March, pp. 171-173; and Part 11 in April, pp. 239-242.

Copyright, 1940, by William Goodman.

Table 6 - End Points for Wet Bulb Lines
Barometric Pressure 25 in.

Wet Bulb Temp. t'	Dry Bulb Temperature, t				Absolute Humidity, w			
	For w=0		For w= 0.022	For w= 0.11	For t=40		For t= 120	For t= 450
	Over Ice	Over Water			Over Ice	Over Water		
1	2	3	4	5	6	7	8	9
-20	-17.88	-18.08						
-19	-16.77	-16.98						
-18	-15.65	-15.88						
-17	-14.53	-14.77						
-16	-13.40	-13.65						
-15	-12.26	-12.53						
-14	-11.12	-11.40						
-13	-9.97	-10.27						
-12	-8.82	-9.13						
-11	-7.66	-7.99						
-10	-6.48	-6.83						
-9	-5.31	-5.68						
-8	-4.12	-4.51						
-7	-2.93	-3.34						
-6	-1.73	-2.16						
-5	-0.51	-0.97						
-4	+0.71	+0.23						
-3	1.94	1.43						
-2	3.18	2.65						
-1	4.43	3.87						
0	5.69	5.10						
1	6.96	6.34						
2	8.25	7.59						
3	9.54	8.58						
4	10.86	10.13						
5	12.18	11.41						
6	13.51	12.71						
7	14.86	14.02						
8	16.22	15.34						
9	17.60	16.68						
10	18.99	18.02						
11	20.41	19.39						
12	21.84	20.77						
13	23.28	22.15						
14	24.75	23.57						
15	26.23	24.99						
16	27.73	26.43						
17	29.25	27.89						
18	30.79	29.36						
19	32.35	30.86						
20	33.93	32.37						
21	35.55	33.91						
22	37.17	35.45						
23	38.83	37.03						
24	40.51	38.63			0.0001003			
25	42.21	40.24			0.0004324	0.0003221		
26	43.96	41.89			0.0007747	0.0004177		
27	45.71	43.55			0.001118	0.0007850		
28	47.49	45.23			0.001469	0.001160		
29	49.31	46.95			0.001826	0.001541		
30	51.16	48.69			0.002190	0.001930		
31	53.06	50.47			0.002562	0.002327		
32	54.95	52.26			0.002935	0.002725		
33		54.10				0.003138		
34		55.97				0.003556		
35		57.85				0.003979		
36		59.78				0.004414		
37		61.74				0.004856		
38		63.73				0.005305		
39		65.75				0.005764		
40		67.81				0.006230		
41		69.91						
42		72.04						
43		74.21						
44		76.42						
45		78.70						
46		80.99						
47		83.34						
48		85.74						
49		88.17						
50		90.68						
51		93.23						
52		95.80						
53		98.48						
54		101.1						
55		103.9						
56		106.7						
57		109.6						
58		112.6						
59		115.5						
60		118.6						
61		121.7					0.0003831	
62		125.0					0.001094	
63		128.3					0.001824	
64		131.6					0.002567	

Wet Bulb Temp. t'	Dry Bulb Temperature, t				Absolute Humidity, w			
	For w=0		For w= 0.022	For w= 0.11	For t=40		For t= 120	For t= 450
	Over Ice	Over Water			Over Ice	Over Water		
1	2	3	4	5	6	7	8	9
65		135.0					0.003335	
66		138.5					0.004109	
67		142.1					0.004914	
68		145.8					0.005729	
69		149.5					0.006564	
70		153.3					0.007429	
71		157.3					0.008316	
72		161.3					0.009223	
73		165.4					0.01015	
74		169.7					0.01111	
75		173.9	77.44				0.01208	
76		178.4	81.80				0.01308	
77		183.0	86.29				0.01412	
78		187.6	90.81				0.01517	
79		192.3	95.46				0.01626	
80		197.2	100.2				0.01737	
81		202.2	105.2				0.01852	
82		207.3	110.1				0.01968	
83		212.6	115.3				0.02090	
84		217.9						
85		223.4						
86		229.1						
87		234.9						
88		240.9						
89		247.0						
90		253.3						
91		259.7						
92		266.2						
93		273.0						
94		280.0						
95		287.1						
96		294.4						
97		301.9						
98		309.7						
99		317.6						
100		325.7						
101		334.0						
102		342.7						
103		351.5						
104		360.6						
105		369.8						
106		379.4						
107		389.4						
108		399.4						
109		409.9						
110		420.7						
111		431.6						
112		442.9						
113								0.0009421
114								0.003381
115								0.005899
116								0.008507
117								0.01119
118								0.01394
119								0.01676
120								0.01972
121								0.02279
122								0.02585
123								0.02908
124						136.4		0.03241
125						150.8		0.03591
126						165.6		0.03950
127						180.6		0.04319
128						196.1		0.04696
129						212.2		0.05090
130						229.0		0.05503
131						246.1		0.05925
132						263.6		0.06356
133						281.8		0.06804
134						301.0		0.07280
135						320.1		0.07756
136						340.3		0.08258
137						361.2		0.08779
138						382.8		0.09316
139						405.4		0.09881
140						428.3		0.1046

See p. 613, October, 1939, HPAC for explanation of method of using these end points.

Table 7 - End Points for Wet Bulb Lines
Barometric Pressure 26 in.

Wet Bulb Temp. t'	Dry Bulb Temperature, t				Absolute Humidity, w			
	For w=0		For w= 0.022	For w= 0.11	For t=40		For t= 120	For t= 450
	Over Ice	Over Water			Over Ice	Over Water		
1	2	3	4	5	6	7	8	9
-20	-17.96	-18.16						
-19	-16.85	-17.06						
-18	-15.74	-15.96						
-17	-14.62	-14.85						
-16	-13.50	-13.74						
-15	-12.37	-12.62						
-14	-11.23	-11.50						
-13	-10.09	-10.37						
-12	-8.94	-9.24						
-11	-7.79	-8.10						
-10	-6.62	-6.96						
-9	-5.45	-5.81						
-8	-4.27	-4.64						
-7	-3.09	-3.48						
-6	-1.89	-2.31						
-5	-0.69	-1.13						
-4	+0.52	+0.06						
-3	1.75	1.26						
-2	2.98	2.47						
-1	4.22	3.68						
0	5.47	4.90						
1	6.73	6.14						
2	8.01	7.38						
3	9.29	8.63						
4	10.59	9.90						
5	11.90	11.17						
6	13.22	12.45						
7	14.56	13.75						
8	15.91	15.06						
9	17.27	16.38						
10	18.65	17.71						
11	20.05	19.07						
12	21.46	20.43						
13	22.88	21.80						
14	24.33	23.20						
15	25.80	24.61						
16	27.28	26.03						
17	28.78	27.47						
18	30.29	28.92						
19	31.84	30.40						
20	33.40	31.89						
21	34.99	33.41						
22	36.59	34.94						
23	38.22	36.49						
24	39.87	38.06						
25	41.54	39.65			0.0003021			
26	43.26	41.27			0.0006384	0.0002815		
27	44.98	42.91			0.0009766	0.0006438		
28	46.74	44.56			0.001320	0.001011		
29	48.53	46.26			0.001672	0.001388		
30	50.35	47.97			0.002032	0.001769		
31	52.20	49.72			0.002395	0.002159		
32	54.06	51.47			0.002761	0.002551		
33		53.28				0.002956		
34		55.11				0.003366		
35		56.96				0.003782		
36		58.86				0.004208		
37		60.78				0.004642		
38		62.73				0.005082		
39		64.71				0.005531		
40		66.73				0.005988		
41		68.78						
42		70.87						
43		73.00						
44		75.16						
45		77.38						
46		79.63						
47		81.92						
48		84.26						
49		86.64						
50		89.09						
51		91.58						
52		94.08						
53		96.70						
54		99.32						
55		102.0						
56		104.7						
57		107.6						
58		110.4						
59		113.3						
60		116.3						
61		119.4						
62		122.5					0.0005494	
63		125.7					0.001262	
64		129.9					0.001975	

Wet Bulb Temp. t'	Dry Bulb Temperature, t				Absolute Humidity, w			
	For w=0		For w= 0.022	For w= 0.11	For t=40		For t= 120	For t= 450
	Over Ice	Over Water			Over Ice	Over Water		
1	2	3	4	5	6	7	8	9
65		132.3					0.002719	
66		135.6					0.003473	
67		139.1					0.004249	
68		142.7					0.005044	
69		146.3					0.005860	
70		150.0					0.006695	
71		153.9					0.007552	
72		157.8					0.008429	
73		161.8					0.009336	
74		165.8					0.01025	
75		170.0					0.01120	
76		174.3	77.89				0.01217	
77		178.7	82.21				0.01317	
78		183.2	86.61				0.01419	
79		187.8	91.13				0.01524	
80		192.5	95.74				0.01631	
81		197.3	100.5				0.01742	
82		202.3	105.3				0.01855	
83		207.4	110.3				0.01971	
84		212.5	115.3				0.02090	
85		217.9						
86		223.4						
87		229.0						
88		234.7						
89		240.6						
90		246.6						
91		252.8						
92		259.1						
93		265.7						
94		272.4						
95		279.2						
96		286.2						
97		293.4						
98		300.9						
99		308.6						
100		316.3						
101		324.4						
102		332.6						
103		341.1						
104		349.8						
105		358.7						
106		367.9						
107		377.4						
108		387.1						
109		397.1						
110		407.4						
111		417.8						
112		428.7						
113		439.9						
114								0.0002770
115								0.002680
116								0.005175
117								0.007722
118								0.01034
119								0.01303
120								0.01587
121								0.01875
122								0.02174
123								0.02480
124								0.02795
125						132.1		0.03127
126						145.8		0.03460
127						160.2		0.03810
128						175.3		0.04178
129						190.3		0.04547
130						206.5		0.04942
131						222.6		0.05338
132						239.0		0.05742
133						256.5		0.06173
134						274.2		0.06613
135						292.7		0.07071
136						311.9		0.07547
137						331.4		0.08032
138						352.3		0.08552
139						373.1		0.09072
140						395.0		0.09620
141						417.2		0.1018
142						441.1		0.1078

See p. 613, October, 1939, HPAC for explanation of method of using these end points.

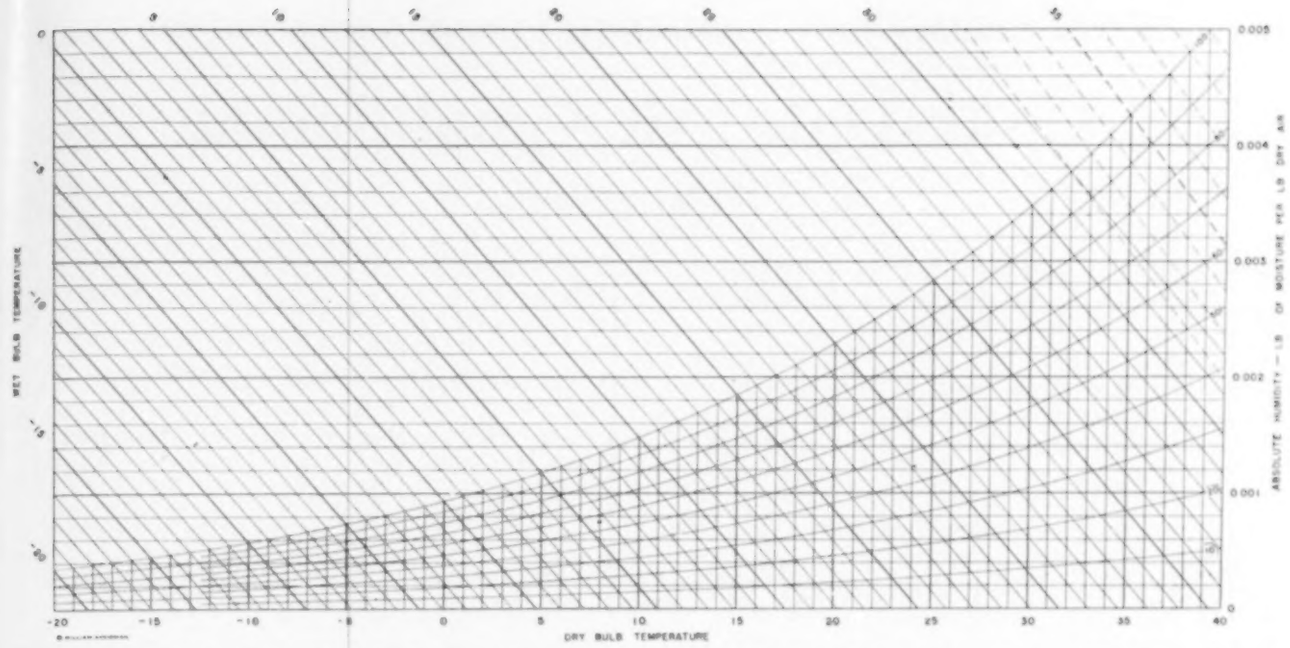


Chart F—This chart is to be used only for the normal barometric pressure of 29.92 in. of mercury. Lines of constant wet bulb temperature are shown instead of lines of constant enthalpy. Slopes of wet bulb lines correspond to enthalpy of ice. For wet bulb lines over subcooled water see Chart D, published on p. 109, February, 1940, HEATING, PIPING AND AIR CONDITIONING

moisture added to the air is positive. However, if the moisture is in the form of ice, the enthalpy of which is negative, then from equation 3 there must be a decrease in the enthalpy of an air-vapor mixture along a wet bulb line drawn for ice.

Appendix 4

Slope of Lines of Constant Dry Bulb Temperature

The enthalpy of an air-vapor mixture is

$$h = 0.24t + wh_g \quad \ldots\ldots [1]$$

Differentiating [1] with t held constant gives the slope of a line of constant dry bulb temperature as

$$\frac{dh}{dw} = h_g \quad \ldots\ldots [2]$$

Now writing equation 4 of the text with $h_2 = h$, and $w_2 = w$,

$$\frac{h - h_1}{w - w_1} = q \quad \ldots\ldots [3]$$

Differentiating [3],

$$\frac{dh}{dw} = q \quad \ldots\ldots [4]$$

Equating [2] and [4],

$$q = h_g \quad \ldots\ldots [5]$$

For the one case where q equals the slope of a line of constant dry bulb temperature, let

$$q = q_D \quad \ldots\ldots [6]$$

Substitute [6] into [5],

$$q_D = h_g \quad \ldots\ldots [7]$$

Therefore, the slope of a line of constant dry bulb temperature on the psychrometric chart is equal to the enthalpy of the vapor mixed with the air.

Now

$$h_g = 1061 + 0.45t \quad \ldots\ldots [8]$$

Accordingly [7] may also be written

$$q_D = 1061 + 0.45t \quad \ldots\ldots [9]$$

where t = dry bulb temperature of line for which slope equals q_D.

[To be continued]

Summary of
The Psychrometric Chart
Its Application and Theory
By William Goodman

Publication of the text of this series on the psychrometric chart and its application and theory was completed last month. Therefore, the appendices are now presented; these show the derivation of the various equations which have appeared in the text sections. Additional tables of end points for wet bulb lines for various barometric pressures are also given this month; some of these tables have been published previously and more are to appear later. The last of the psychrometric charts appears also with this installment; it is for the normal barometric pressure of 29.92 in. of mercury, and has lines of constant wet bulb temperature rather than lines of constant enthalpy . . . . . The series of which this installment is a part has included new psychrometric charts for the low, medium and high temperature ranges, discussion of the theory underlying them, and instructions and supplemental data for solving problems encountered in practice

Air Conditioning Primer

[An Air-Conditioning Primer—The ABC of Air Conditioning, by William Hull Stangle. 1st ed. 1940. 236 + vii pp., 6x9 in., clothbound. Published by McGraw-Hill Book Co., 330 W. 42nd St., New York, N. Y. Price, $2.50.]

This new book is well named a "primer," for it has been written in clear and understandable terms and illustrated with many useful sketches to explain the fundamentals and application of air conditioning. The first part is devoted to fundamentals and the second part to application and apparatus; an appendix gives a great deal of useful data and there is a large psychrometric chart inserted.

The titles of the chapters give a good idea of the scope of this work and also indicate something of the style in which it is written: Definitions: The Simple Truth About Air Conditioning; Preamble: Why Comfort Air Conditioning?; Heat: Nature Takes a Hand; Air: An Ocean—We Live in It; People: You and I—What Makes Us Tick; Enclosures: All Wrapped Up in Cellophane; Application: The Shoe Must Fit; Apparatus: It's in the System.

Old Cooling and Ventilating System Converted to

Up-to-Date Air Conditioning

By Henry W. Moore*

LAST summer the Busse & Borgmann Co., 50 year old Cincinnati funeral directors, completely modernized the air conditioning system in their Central Parkway home. The work included installation of mechanical refrigeration equipment for the existing cooling and ventilating system, and self-contained air conditioning units in two rooms not served by the old duct system.

When the contractor approached the owners in an effort to interest them in improving their air conditioning, he met with great skepticism. Busse & Borgmann stated that two previous attempts had been made, they weren't at all satisfied with the results, and hence were dubious about making any further investment. They have since stated that they are well pleased with this additional investment.

The space originally served by the duct system comprises two funeral service parlors having a total area of 2200 sq ft on the first floor of the two story building. The building is long and rambling and resembles in appearance a country club. When the changes were being considered, the funeral directors stated that they wished also to air condition the two family rooms, each with an approximate area of 300 sq ft, and an office of 325 sq ft area. These three rooms are also on the first floor and it was desired to connect them to the existing duct system if practical. Furthermore, the owners wished to cool the 1350 sq ft casket display sales room on the second floor.

After considerable thought, it was decided to install self-contained summer conditioning units in two rooms because it was impractical to extend the duct system to these spaces; this greatly simplified the over-all problem. A ¾ hp air cooled, self-contained room cooler was installed in the north family room on the first floor, and a 5 hp self-contained water cooled unit was installed in the display room on the second floor.

The air supply system for the two main service rooms was originally a straight ventilation system, and later a well had been dug and water cooling coils installed in the air stream, the 58 deg well water being pumped through the coils. Neither of these systems had cooled the building properly. This existing duct work was utilized for the present system. A run-out was provided and a register installed to supply air to the office space. A return duct made of prefabricated asbestos material was run from the first floor to the air mixing box on the supply fan inlet. This duct now draws all return air from the south family room and thereby serves to maintain proper air conditions in that room without it being necessary to supply any air directly to the room.

The attic is the fan room. (We are at a loss to understand why this hot location was chosen originally, as it seems that it would have been much better had the cooling equipment been situated in the basement.) Before last summer's changes were made, the supply blower merely drew the hot air from the attic and blew it through the duct system into the rooms below, the air passing through the well water coils enroute. The coils did only a small amount of cooling, as an inadequate supply of water was available most of the time. Hence the air that was distributed into the service rooms prior to the installation of the mechanical refrigeration was not very cool and, naturally, the parlors were not comfortable in hot weather. No outside air was provided for the system and the return air was merely taken up the stairwell through the second floor to the attic.

There were two blowers in the attic connected to the one duct system to the parlors. One of these fans was for supplying air as mentioned above, and the other for exhausting air (when so desired) through the fan duct system. Automatic dampers had been installed and could be easily shifted so that the old arrangement was either a supply or exhaust system. The modernization work included disconnecting the exhaust blower from the parlor duct system.

The duct connecting the exhaust blower to the outside was left intact so that the blower can be used as an exhaust fan for ventilating the attic in the future, if the owners wish to do so. The air mixing box referred to above was installed on the supply fan inlet. This mixing box was connected to a duct from a window to introduce outside air to the system, as well as being connected

Summary of
Old Cooling and Ventilating System
Converted to Up-to-Date Air Conditioning
By Henry W. Moore

There are often opportunities to utilize existing ventilating equipment when it is desired to install an air conditioning system. At the Busse & Borgmann funeral home in Cincinnati, for example, there was a duct system originally installed to which water cooling coils were later added. Water for circulation through the coils was obtained from a well, but as the quantity of water available was inadequate most of the time, conditions in the occupied space were not satisfactory. . . . . When air conditioning was installed last summer, the existing duct work was utilized and a 10 hp condensing unit was put in to furnish refrigeration. The well water is used for condensing, and if not sufficient, an automatic water valve supplements it with city water. . . . . The system is so controlled that if the well water alone will do the cooling job it is used, and if mechanical refrigeration is needed, the compressor will start; in mild weather, the fan alone can be operated for air circulation and ventilation. . . . . Because it was impractical to run ducts to part of the space, a self-contained, air cooled conditioning unit is used in one of the first floor rooms and a self-contained water cooled unit serves a second floor room

*Manager, Air Conditioning Engrg. Dept., Bimel Co.

to the return duct. Permanent, washable type steel air filters were installed in the mixing box, as there were no air filters on the original system. The air mixing box and the fan were thoroughly insulated against the high temperature of the attic. The supply duct was already insulated, and since the return duct was made of an insulating board material, it was not necessary to insulate that.

A 10 ton "Freon" direct expansion evaporator cooling coil having four rows of tubes in the direction of air flow was installed on the leaving air side of the water coils. Thus the water coils became precooling coils. The direct expansion coils were connected to a 10 hp water cooled condensing unit which was situated in the garage on the first floor level. Water from the deep well, when available, is run through the condenser. If the well water is not sufficient for condensing purposes, an automatic water valve automatically allows city water to flow to the condenser in sufficient quantity to supplement the well water.

The main system is controlled by means of a two step thermostat in the south family room beneath the return air grille. The first step of this thermostat starts the pump and the cooling by means of the water coils; if necessary, the second step of the thermostat energizes the compressor motor and starts the mechanical refrigeration. Of course, in mild weather, the fan alone can be operated for air circulation and ventilation, without using any refrigeration.

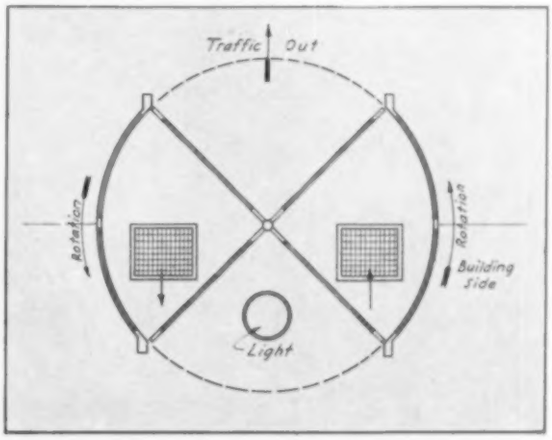
The installation was completed August 15, 1939. About two weeks later, the temperature in Cincinnati reached 102 deg and the owners reported that during that time excellent results were obtained when the parlors were crowded for funerals.

Two self-contained summer air conditioning units were installed for two of the rooms because it was impractical to extend the duct system to these spaces; this greatly simplified the over-all problem. A ¾ hp air cooled unit is used for the first floor family room and a 5 hp water cooled unit serves the display room on the second floor. The main system is controlled by a two step thermostat, the first step governing the pump and the well water cooling and the second step the mechanical refrigeration

Unit Heater Over Revolving Door Solves Entrance Heating Problem

By John G. Eadie*

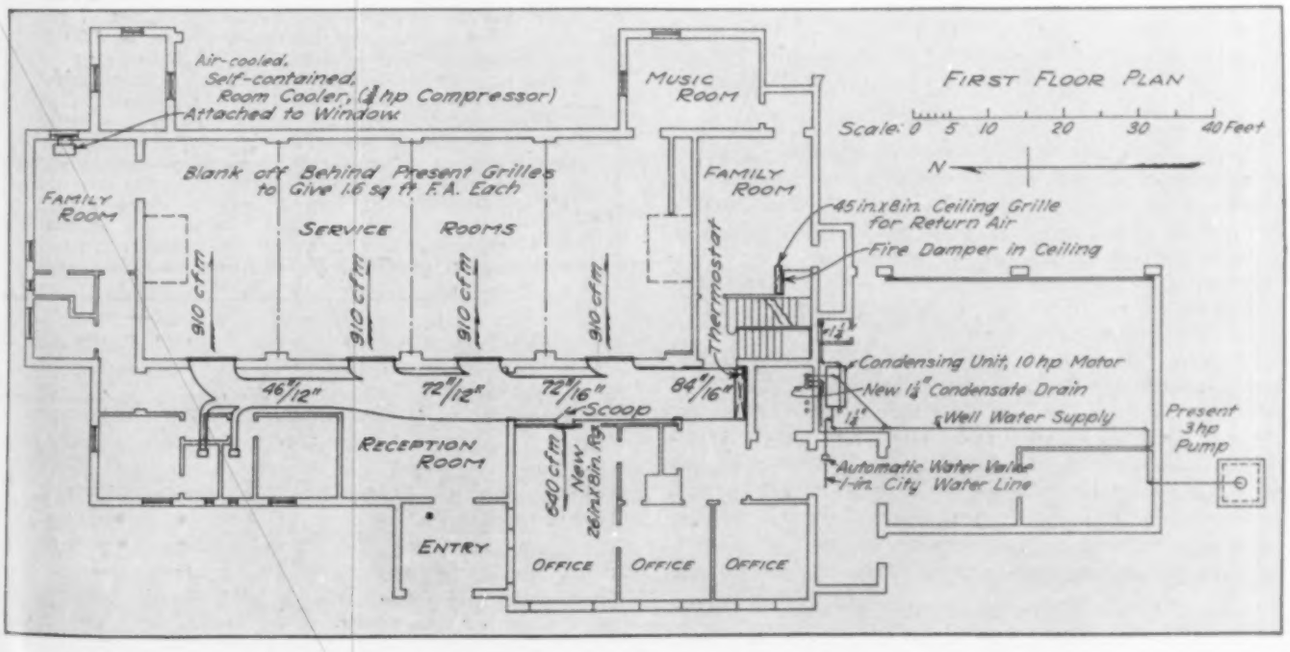
The article entitled Unit Heaters Prevent Cold Drafts at Building and Store Entrances, by D. R. Rippey, published in the April HPAC, invited readers to submit examples of other methods of installing units.



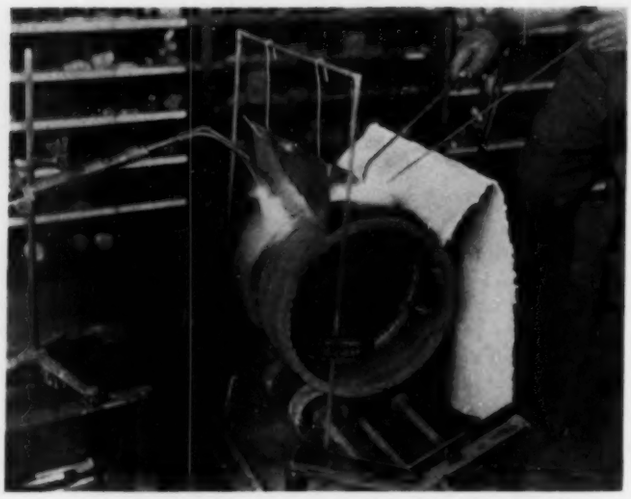
An effective way to heat the cold air brought in by a revolving door is to mount a small unit heater above the door, connecting the suction and discharge to registers recessed in the door's ceiling, as shown in this sketch. Air at room temperature is thus drawn up into the unit, heated, and discharged back into the incoming cold air

We have found a most effective way to heat the cold air brought in by revolving doors is to mount a small unit heater above the door and connect the suction and discharge to two registers recessed in the ceiling of the revolving door. By placing one register over the outgoing side and the other over the incoming side, and both inside the transverse axis of the door, air at room temperature is drawn up into the unit heater, heated, and discharged back into the cold air being carried into the building by the door.

*Eadie, Freund and Campbell, Consulting Engineers.



Oxy-Acetylene Welding Procedure for High Pressure and Temperature Piping



Welding pipe using continuous preheat

OXY-ACETYLENE welding of carbon-molybdenum piping for high pressure, high temperature service was the subject of a two-part paper presented at the 40th annual convention of the International Acetylene Association held last month in Milwaukee. The first part was prepared by R. M. Rooke* and F. C. Saacke*, and covered laboratory development of a welding procedure. The second part was devoted to its field testing and application, and was presented by A. N. Kugler.†

The laboratory development paper reviewed the investigations of a program which preceded recommendation of procedures for this welding process. Development of suitable welding rod, determination of satisfactory welding techniques, and experiments with various methods of both preheat and post-heat were described in some detail. The "discussion of results" with which the authors concluded their paper was as follows:

The principles involved in the thermal treatment of carbon-molybdenum alloy steel welds are no different from those applicable to the majority of low alloy steel weldable materials. The methods of heat treatment can be divided into three classes: preheating, concurrent heating, and post-heating. The thermal treatments, of course, may be modified or omitted at the discretion of the engineer in charge or the designer when backed by process and operator qualification tests.

Preheating—In the oxy-acetylene welding of ASTM 206-38T carbon-molybdenum alloy steel pipe, it is demonstrable that separate preheating as a means of preventing cracking of the weld or base metal is entirely unnecessary. The nature of the oxy-acetylene flame creates gradual temperature gradients, low thermal stresses, and permits the application of the welding flame to the steel surface with little danger of cracking. On the other hand, the use of separate preheating in the application of oxy-acetylene welding to carbon-molybdenum steel possesses distinct advantages that make it advisable to continuously preheat the base metal ahead of the welding flame for the highest quality of work on the heavier wall thicknesses.

Concurrent Heating—The deposition of weld metal with high ductility is governed by the time, temperature, and working conditions when molten. The less that weld metal is overheated and the quieter it is deposited, the greater will be the ductility. With a single torch, the same tip does both the welding and preheating of the pipe. As the welding heat is cut down to secure more sound weld metal, the pipe preheat suffers and the tendency is to secure a weak bond. The proper balance between welding and preheating may be obtained with single

*Apparatus Research and Development Dept., Air Reduction Sales Co.
†Mechanical Engineer, Applied Engrg. Dept., Air Reduction Sales Co.

Summary of Oxy-Acetylene Welding Procedure for High Pressure and Temperature Piping

Oxy-acetylene welding of carbon-molybdenum piping for high pressure, high temperature service was the subject of a two-part paper presented at the International Acetylene Association's convention last month. The first part, by R. M. Rooke and F. C. Saacke, covered laboratory development of a welding procedure, and the second part, by A. N. Kugler, was devoted to its field testing and application. This paper is abstracted here, and excerpts of the particularly important sections of the discussions are given. . . . . Based upon the work, a "process specification for oxy-acetylene fusion welding of carbon-molybdenum steel pressure pipe lines" was prepared as follows: *Base Material:* The base metal shall conform to American Society for Testing Materials specification serial designation A206-38T. . . . *Process:* The welding shall be performed by the oxy-acetylene process. . . . *Filler Metal:* The filler metal shall be carbon-molybdenum oxy-acetylene welding rod. . . . *Welding Groove:* The welding groove shall conform to details as shown in Fig. 1. The same welding groove shall be used for vertical and horizontal pipe welds. When it becomes necessary to bevel pipe in the field, machine guided oxy-acetylene torches shall be used. It shall not be necessary to provide a land or shoulder on these joints. . . . *Cleaning of Welding Groove:* Prior to welding, the edges of the pipes and the surfaces adjacent thereto shall be thoroughly cleaned of all scale, rust, grease or oil. A thin film of linseed oil will be permitted for the preservation of machine tool beveled surfaces. . . . *Welding Equipment:* Welding torches of an approved type shall be used. Sizes of welding tips to be employed shall be as shown in Table 1. . . . *Nature of the Flame:* The flame used for welding shall be neutral ranging to a slight excess of acetylene. . . . *Method of Welding:* The method of welding shall be "forehand" or "backhand" as the position of work indicates most expedient. . . . *Number of Layers and Method of Deposition:* The number of layers of weld metal shall be as shown in Fig. 2. The size of welding rods to be used shall be substantially as indicated in Fig. 2. For horizontal pipe rolling welds and for vertical pipe position welds, each layer shall be deposited in a continuous circuit of the pipe. When vertical pipe position welds are in difficult position the method of deposition of layers may be varied but shall conform substantially to that given below for horizontal pipe position welds. For horizontal pipe position welds each layer shall be started at the top center line and progress downward to the bottom center line. It shall then be restarted (exercising proper precautions to insure fusion at this point) at the top center line and progress downward, on opposite side, to bottom center line where it meets and is fused with previous deposit. . . . *Cleaning of Weld:* Each layer shall be wire brushed for removal of loose scale before laying down next layer

tips for standard weight pipe. As the wall thickness increases, however, the pipe needs more preheat. If sufficient heat is used in a single flame to provide for continuous welding, the weld metal is usually overheated and of mediocre ductility. To allow the weld metal to be deposited quietly without overheating by the use of a smaller welding flame, the pipe must be preheated either continuously during the welding from a source other than the welding flame, or the welding flame must be applied intermittently to the pipe walls as a preheating flame during the course of the welding operation. This preheating, to distinguish it from any heating of the base metal prior to the application of the welding flame, is termed "concurrent heating."

It is not meant to infer that concurrent heating in the oxy-acetylene welding of wall thicknesses over ½ in. is necessary

Field test: Oxy-acetylene welding, 14 in. OD by 0.75 in. wall carbon-molybdenum pipe joint

as with the requisite experience, a good operator can still secure strong ductile weld metal free from troublesome porosity or inclusions without any concurrent heating. Wherever possible, however, a heating torch with a single or multiflame tip should be set up to maintain a separate preheat directly in advance of the welding flame, whether operated manually or semi-automatically. This concurrent heating improves the speed of welding at the same time as it improves the quality.

Post-heating—Since early in 1935 it has become increasingly evident that alloy steel weld metal, when deposited with the oxy-acetylene flame, should have the original cast structure refined by a heat treatment operation following the completion of the weld. The grain refining effect of the multilayer deposition of weld metal is not quite satisfactory for optimum results as the upper layer of weld metal is not so fine grained as the remainder of the weld.

The ideal treatment appears to be a 1500 F furnace anneal, but as this is oftentimes impracticable due to lack of available and economically operable equipment and as it is often unsatisfactory due to a reduction in ultimate tensile strength, it is recommended in view of the results of weld tests that the weld after completion be normalized by being heated above the critical and allowed to cool slowly in still air.

This normalizing treatment may be accomplished in two ways. First, it may result from a progressive pass of the welding torch around the pipe. Thus, after the welding is completed, the entire weld is reheated to temperatures above 1600 F by heating the face of the weld to at least 1750 F in a continuous circumferential traverse with the torch starting at the end of the last layer of weld metal. Second, the weld may be allowed to cool until the entire weld has cooled below the critical temperature (or below a red) after which it is reheated uniformly to 1600 F and then allowed to cool slowly in still air.

The difference between the two methods lies in the uniformity with which the welds are normalized. A progressive normalizing pass with the welding torch oftentimes does not give as uniform ductility as a weld that has been allowed to cool entirely below a red and then reheated all together to a normalizing temperature. The former method is faster but requires more experience and an occasional etch test for grain size as a check.

Finally, stress relieving at the completion of the weld is still used although somewhat modified. If a progressive torch normalizing operation has been used, then the pipe is reheated uniformly to not less than 1100 F before being allowed to cool. If a uniform normalizing heat has been applied, the normalizing treatment can be considered a stress relief.

Field Testing and Application

The second part, on field testing and application, summarized the results of some 20 field tests of carbon-molybdenum gas welding rods and the attendant welding procedure. Results of tensile, free bend, restricted bend and nick break tests were tabulated and indicated that requirements are readily exceeded by welds made in the manner under discussion. Data were also given on impact values and hardness readings on both weld metal and heat-affected areas.

A process specification for oxy-acetylene fusion welding of carbon-molybdenum steel pressure pipe lines was presented, including such matters as required base metal, welding rod, bevel preparation, and size of welding tip. The value of stress relieving was discussed and recommended methods described, including a recently developed method designated as "short time stress relief." Results of such post-heating were shown to be in conformance with present requirements. The following paragraphs are excerpts from the paper.

The open, single vee, butt joint without backing up strip or liner was used almost exclusively. The bevel preparation comprehended 30 to 37½ deg bevel angles with or without the usual land depending on whether the joints were prepared by machine tool beveling or machine torch cutting. The multilayer welding technique was employed exclusively with but the one slight modification of thinner layers. On rolling welds it was found entirely acceptable to employ layers as thick as $\frac{3}{16}$ in. On position welds it was found desirable under some adverse conditions to resort to layers as thin as $\frac{5}{32}$ in. Continuous deposition of layers is preferable in this welding.

The following rod sizes have been found to be desirable for the various thicknesses welded under the given conditions: for rolling welds the first layer should be made with the ⅛ in. diameter rod and the intermediate layers up to ¾ in. thickness with $\frac{3}{16}$ in. rods; intermediate layers above ¾ in. thickness should be made with ¼ in. rods and the final layer is best made with the ¼ in. rod. On position welds the first layer should be made with ⅛ in. rods and the intermediate and final layers with $\frac{3}{16}$ in. rods.

In addition to the field tests, one small installation has been completed in the middle-west. This system operates at 1800 lb per sq in. and 900 F, and involves the following sizes of pipe: 2 in. by 0.438 in., 3 in. by 0.563 in. and 4 in. by 0.674 in. This piping was installed for service to a group of heaters. Multilayer welding employing three layers of weld metal was used on all three sizes of pipe. The work was performed under the usual field difficulties and involved all of the usual types of joints. Stress relieving was accomplished with oxy-acetylene torches heating the joints uniformly to a temperature

of 1400-1450 F and immediately upon reaching that temperature the joints were covered with asbestos blankets or paper and any open ends were plugged. The stress relieving temperature was checked with a pyrometer. This project was installed by the owner's forces and no attempt was made to rush the job. The following production data were obtained during the course of construction:

3 in. position weld 50 min plus 5 min for stress relief
3 in. rolling weld 40 min plus 5 min for stress relief
2 in. position weld 40 min plus 4 min for stress relief
2 in. rolling weld 30 min plus 3 min for stress relief

The daily production rate averaged eight 3 in. or ten 2 in. welds. Under test conditions and in approximately one year's operation no leaks or failures of any nature have developed.

Additional data, although admittedly incomplete, have been reported from several points. An 8 in., 0.625 in. wall carbon-molybdenum pipe was welded in 1½ hr (roll weld) and stress relieved at 1400-1450 F in 17 min with two torches. This joint required 80 cu ft of oxygen, 70 cu ft of acetylene and 2.75 lb of rod. Post-heating consumed 45 cu ft of oxygen and 38 cu. ft of acetylene. Other reported data include 2¼ hr for welding 10⅝ in. by 0.718 in. wall pipe and 3 hr for 14 in. by 0.75 in. wall pipe. It should be appreciated that this information is an insufficient basis for estimating purposes.

Specification Prepared

Based upon the field tests and applications, a "Process Specification for Oxy-acetylene Fusion Welding of Carbon-Molybdenum Steel Pressure Pipe Lines" has been prepared which is given herewith.

Base Material: The base metal shall conform to American Society for Testing Materials specification serial designation A206-38T.

Process: The welding shall be performed by the oxy-acetylene process.

Filler Metal: The filler metal shall be carbon-molybdenum oxy-acetylene welding rod.

Welding Groove: The welding groove shall conform to details as shown in Fig. 1. The same welding groove shall be used for vertical and horizontal pipe welds. When it becomes necessary to bevel pipe in the field, machine guided oxy-acetylene torches shall be used. It shall not be necessary to provide a land or shoulder on these joints.

Cleaning of Welding Groove: Prior to welding, the edges of the pipes and the surfaces adjacent thereto shall be thoroughly cleaned of all scale, rust, grease or oil. A thin film of linseed oil will be permitted for the preservation of machine tool beveled surfaces.

Welding Equipment: Welding torches of an approved type shall be used. Sizes of welding tips to be employed shall be as shown in Table 1.

Nature of the Flame: The flame used for welding shall be neutral ranging to a slight excess of acetylene.

Method of Welding: The method of welding shall be "forehand" or "backhand" as the position of work indicates most expedient. *Definitions*—Forehand welding is that method of welding in which the torch flame and welding rod are so disposed that the flame points ahead in the direction of welding and the rod precedes the flame. Backhand welding is that method of welding in which the torch flame and welding rod are so disposed that the flame points back at the completed weld and envelops the molten puddle, and the rod is interposed between flame and puddle.

Number of Layers and Method of Deposition: The number of layers of weld metal shall be as shown in Fig. 2. The size of welding rods to be used shall be substantially as indicated in Fig. 2. For horizontal pipe rolling welds and for vertical pipe position welds, each layer shall be deposited in a continuous circuit of the pipe. When vertical pipe position welds are in difficult positions the method of deposition of layers may be varied but shall conform substantially to that given below for

[*Concluded on p.* 312]

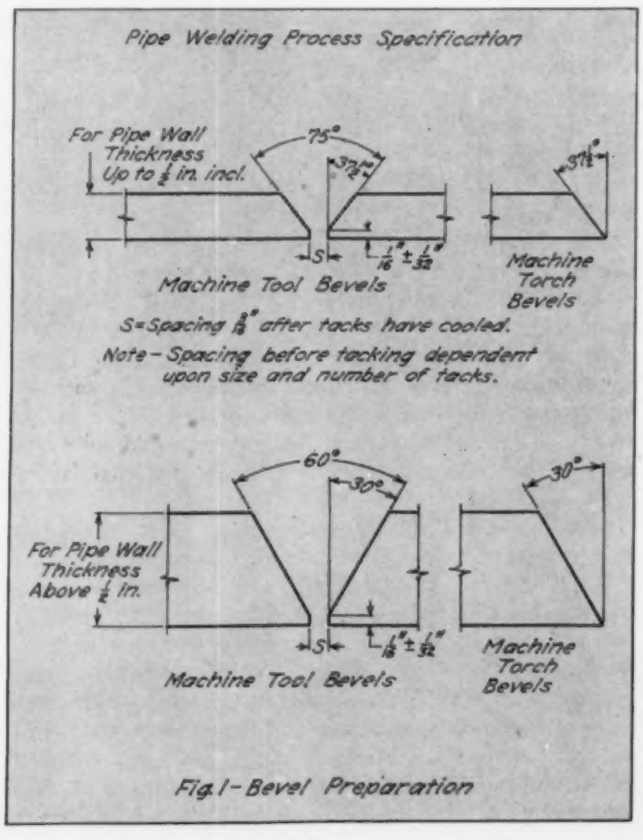
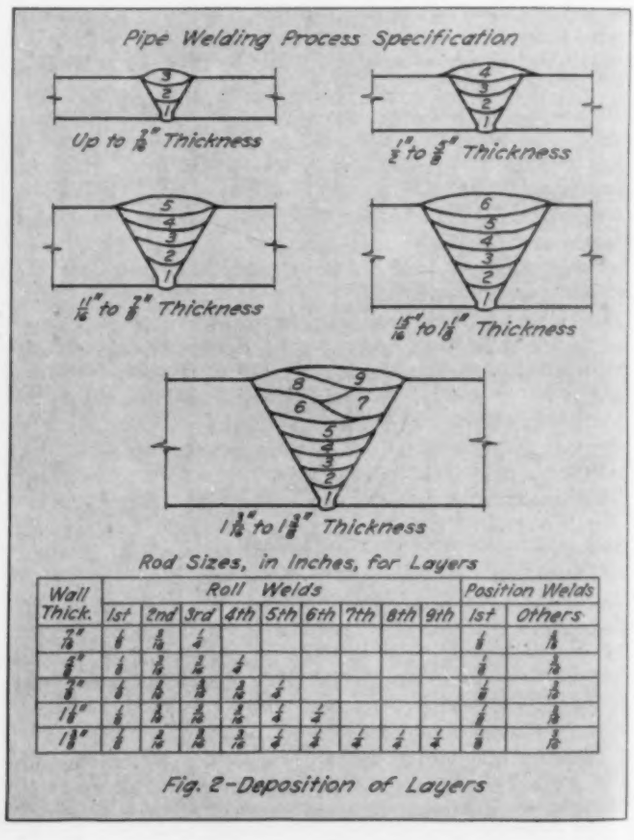


Fig. 1 – Bevel Preparation


Pipe Welding Process Specification
Up to 3/8" Thickness
1/2" to 5/8" Thickness
11/16" to 7/8" Thickness
15/16" to 1 1/8" Thickness
1 3/16" to 1 3/8" Thickness

Rod Sizes, in Inches, for Layers

Wall Thick.	Roll Welds									Position Welds	
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	1st	Others
7/16"	1/8	1/8	1/4							1/8	1/8
5/8"	1/8	1/8	1/8	1/4						1/8	1/8
7/8"	1/8	1/8	1/8	1/8	1/4					1/8	1/8
1 1/4"	1/8	1/8	1/8	1/8	1/4	1/4				1/8	1/8
1 3/8"	1/8	1/8	1/8	1/8	1/4	1/4	1/4	1/4	1/4	1/8	1/8

Fig. 2 – Deposition of Layers

Properties of Mixtures of Air and Saturated Water Vapor for Barometric Pressures from 22 In. to 32 In. of Mercury

By William Goodman*

Barometric Pressure 30 In. of Mercury

All tabulated values (except temperatures and pressures) are quantities per pound of dry air in the mixture.

Temp Deg Fahr	Absolute Humidity		Volume		Humid Specific Heat	1061w	Enthalpy (Heat Content)		Temp Deg Fahr	Absolute Humidity		Volume		Humid Specific Heat	1061w	Enthalpy (Heat Content)	
	Pounds	Grains	Dry Air Cu Ft	Volume Increase of Humid Air Per Cent			Water Vapor Btu	Air-Vapor Mixture Btu		Pounds	Grains	Dry Air Cu Ft	Volume Increase of Humid Air Per Cent			Water Vapor Btu	Air-Vapor Mixture Btu
t	w	w	v_D		s^*		h_v	h	t	w	w	v_D		s^*		h_v	h
1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
−40	0.0001161	0.8124	10.55	0.01866	0.2401	0.1231	0.1211	−9.479	40	0.005183	36.28	12.56	0.8329	0.2423	5.499	5.594	15.19
−39	.0001229	0.8600	10.58	.01975	.2401	.1304	.1282	−9.232	41	.005389	37.73	12.59	.8662	.2424	5.718	5.819	15.66
−38	.0001302	0.9112	10.60	.02093	.2401	.1381	.1359	−8.984	42	.005604	39.23	12.61	.9004	.2425	5.946	6.054	16.13
−37	.0001378	0.9647	10.63	.02216	.2401	.1462	.1439	−8.736	43	.005825	40.77	12.64	.9361	.2426	6.180	6.294	16.61
−36	.0001459	1.021	10.65	.02345	.2401	.1548	.1524	−8.488	44	.006054	42.38	12.66	.9731	.2427	6.423	6.544	17.10
−35	0.0001542	1.080	10.68	0.02480	0.2401	0.1637	0.1612	−8.239	45	0.006295	44.06	12.69	1.011	0.2428	6.679	6.808	17.61
−34	.0001632	1.143	10.70	.02624	.2401	.1732	.1707	−7.989	46	.006541	45.78	12.71	1.051	.2429	6.940	7.076	18.12
−33	.0001726	1.208	10.73	.02774	.2401	.1831	.1805	−7.740	47	.006794	47.56	12.74	1.092	.2431	7.209	7.354	18.63
−32	.0001825	1.278	10.75	.02934	.2401	.1936	.1910	−7.489	48	.007058	49.41	12.76	1.134	.2432	7.489	7.643	19.16
−31	.0001927	1.349	10.78	.03098	.2401	.2045	.2018	−7.238	49	.007331	51.32	12.79	1.178	.2433	7.778	7.941	19.70
−30	0.0002037	1.426	10.80	0.03276	0.2401	0.2162	0.2134	−6.987	50	0.007615	53.31	12.81	1.223	0.2434	8.080	8.253	20.25
−29	.0002152	1.506	10.83	.03459	.2401	.2283	.2255	−6.735	51	.007909	55.36	12.84	1.271	.2436	8.391	8.574	20.81
−28	.0002270	1.589	10.85	.03650	.2401	.2409	.2380	−6.482	52	.008206	57.44	12.86	1.319	.2437	8.707	8.899	21.38
−27	.0002398	1.678	10.88	.03855	.2401	.2544	.2515	−6.229	53	.008524	59.67	12.89	1.369	.2438	9.044	9.249	21.97
−26	.0002529	1.771	10.90	.04066	.2401	.2684	.2654	−5.975	54	.008844	61.91	12.91	1.421	.2440	9.383	9.599	22.56
−25	0.0002668	1.867	10.93	0.04289	0.2401	0.2830	0.2800	−5.720	55	0.009175	64.24	12.94	1.474	0.2441	9.735	9.963	23.16
−24	.0002814	1.970	10.95	.04524	.2401	.2986	.2955	−5.465	56	.009524	66.67	12.96	1.530	.2443	10.10	10.34	23.78
−23	.0002968	2.078	10.98	.04772	.2401	.3149	.3119	−5.208	57	.009877	69.14	12.99	1.587	.2444	10.48	10.73	24.41
−22	.0003128	2.189	11.00	.05028	.2401	.3318	.3287	−4.951	58	.01025	71.74	13.01	1.646	.2446	10.87	11.14	25.06
−21	.0003295	2.307	11.03	.05298	.2402	.3496	.3465	−4.694	59	.01063	74.38	13.04	1.707	.2448	11.27	11.56	25.72
−20	0.0003472	2.431	11.05	0.05582	0.2402	0.3684	0.3653	−4.435	60	0.01102	77.11	13.06	1.770	0.2450	11.69	11.98	26.38
−19	.0003658	2.561	11.08	.05881	.2402	.3881	.3850	−4.175	61	.01142	79.95	13.09	1.835	.2451	12.12	12.43	27.07
−18	.0003850	2.695	11.10	.06190	.2402	.4085	.4054	−3.915	62	.01185	82.94	13.12	1.903	.2453	12.57	12.90	27.78
−17	.0004052	2.836	11.13	.06514	.2402	.4299	.4268	−3.653	63	.01228	85.97	13.14	1.972	.2455	13.03	13.38	28.50
−16	.0004267	2.987	11.15	.06859	.2402	.4527	.4496	−3.390	64	.01272	89.05	13.17	2.044	.2457	13.50	13.86	29.22
−15	0.0004486	3.140	11.18	0.07213	0.2402	0.4760	0.4730	−3.127	65	0.01319	92.34	13.19	2.118	0.2459	14.00	14.38	29.98
−14	.0004719	3.303	11.20	.07587	.2402	.5007	.4977	−2.862	66	.01366	95.63	13.22	2.194	.2462	14.49	14.90	30.74
−13	.0004964	3.475	11.23	.07981	.2402	.5267	.5238	−2.596	67	.01416	99.11	13.24	2.274	.2464	15.02	15.45	31.53
−12	.0005218	3.652	11.25	.08388	.2402	.5536	.5508	−2.329	68	.01466	102.7	13.27	2.355	.2466	15.56	16.01	32.33
−11	.0005480	3.836	11.28	.08810	.2403	.5814	.5787	−2.061	69	.01519	106.3	13.29	2.439	.2468	16.11	16.58	33.14
−10	0.0005763	4.034	11.31	0.09266	0.2403	0.6115	0.6089	−1.791	70	0.01573	110.1	13.32	2.526	0.2471	16.69	17.18	33.98
−9	.0006051	4.236	11.33	.09728	.2403	.6420	.6396	−1.520	71	.01629	114.0	13.34	2.616	.2473	17.28	17.80	34.84
−8	.0006360	4.452	11.36	.1022	.2403	.6747	.6725	−1.248	72	.01687	118.1	13.37	2.709	.2476	17.90	18.44	35.72
−7	.0006673	4.671	11.38	.1073	.2403	.7080	.7059	−0.9741	73	.01746	122.2	13.39	2.804	.2479	18.53	19.10	36.62
−6	.0007003	4.902	11.41	.1126	.2403	.7430	.7411	−0.6989	74	.01808	126.5	13.42	2.903	.2481	19.18	19.78	37.54
−5	0.0007354	5.148	11.43	0.1182	0.2403	0.7802	0.7786	−0.4214	75	0.01871	131.0	13.44	3.004	0.2484	19.85	20.48	38.48
−4	.0007714	5.400	11.46	.1240	.2404	.8184	.8170	−0.1430	76	.01936	135.5	13.47	3.109	.2487	20.54	21.20	39.44
−3	.0008090	5.663	11.48	.1301	.2404	.8584	.8573	+0.1373	77	.02005	140.3	13.49	3.218	.2490	21.27	21.96	40.44
−2	.0008488	5.942	11.51	.1365	.2404	.9006	.8998	0.4198	78	.02074	145.2	13.52	3.330	.2493	22.00	22.73	41.45
−1	.0008903	6.232	11.53	.1431	.2404	.9446	.9442	0.7042	79	.02145	150.2	13.54	3.445	.2497	22.76	23.52	42.48
0	0.0009326	6.528	11.56	0.1499	0.2404	0.9895	0.9895	0.9895	80	0.02219	155.3	13.57	3.563	0.2500	23.55	24.34	43.54
1	.0009771	6.840	11.58	.1571	.2404	1.037	1.037	1.277	81	.02296	160.7	13.59	3.686	.2503	24.36	25.19	44.63
2	.001024	7.166	11.61	.1646	.2405	1.086	1.087	1.567	82	.02375	166.2	13.62	3.812	.2507	25.20	26.06	45.74
3	.001072	7.507	11.63	.1724	.2405	1.138	1.139	1.859	83	.02456	171.9	13.64	3.943	.2511	26.06	26.97	46.89
4	.001124	7.865	11.66	.1806	.2405	1.192	1.194	2.154	84	.02539	177.7	13.67	4.076	.2514	26.94	27.89	48.05
5	0.001176	8.233	11.68	0.1891	0.2405	1.248	1.251	2.451	85	0.02625	183.8	13.69	4.214	0.2518	27.85	28.85	49.25
6	.001231	8.616	11.71	.1979	.2406	1.306	1.309	2.749	86	.02715	190.0	13.72	4.357	.2522	28.80	29.84	50.48
7	.001288	9.017	11.73	.2071	.2406	1.367	1.371	3.051	87	.02807	196.5	13.74	4.504	.2526	29.78	30.86	51.74
8	.001348	9.435	11.76	.2167	.2406	1.430	1.435	3.355	88	.02901	203.1	13.77	4.655	.2531	30.78	31.91	53.03
9	.001411	9.874	11.78	.2268	.2406	1.497	1.502	3.662	89	.02999	209.9	13.79	4.813	.2535	31.82	33.01	54.37
10	0.001475	10.32	11.81	0.2371	0.2407	1.565	1.571	3.971	90	0.03100	217.0	13.82	4.974	0.2540	32.89	34.12	55.72
11	.001543	10.80	11.83	.2481	.2407	1.637	1.645	4.285	91	.03204	224.3	13.84	5.141	.2544	33.99	35.28	57.12
12	.001613	11.29	11.86	.2594	.2407	1.712	1.720	4.600	92	.03310	231.7	13.87	5.311	.2549	35.11	36.46	58.54
13	.001685	11.79	11.88	.2709	.2408	1.788	1.797	4.917	93	.03420	239.4	13.89	5.488	.2554	36.29	37.70	60.02
14	.001762	12.34	11.91	.2833	.2408	1.870	1.881	5.241	94	.03534	247.4	13.92	5.670	.2559	37.50	38.97	61.53
15	0.001841	12.89	11.93	0.2960	0.2408	1.954	1.966	5.566	95	0.03651	255.6	13.94	5.858	0.2564	38.74	40.27	63.07
16	.001923	13.46	11.96	.3091	.2409	2.040	2.054	5.894	96	.03771	264.0	13.97	6.051	.2570	40.01	41.62	64.66
17	.002008	14.06	11.98	.3228	.2409	2.130	2.146	6.226	97	.03895	272.6	14.00	6.249	.2575	41.33	43.00	66.28
18	.002097	14.68	12.01	.3371	.2409	2.224	2.241	6.561	98	.04024	281.7	14.02	6.456	.2581	42.70	44.44	67.96
19	.002189	15.32	12.03	.3520	.2410	2.323	2.342	6.902	99	.04157	291.0	14.05	6.668	.2587	44.10	45.92	69.68
20	0.002284	15.99	12.06	0.3672	0.2410	2.423	2.444	7.244	100	0.04292	300.4	14.07	6.885	0.2593	45.54	47.43	71.43
21	.002385	16.69	12.08	.3834	.2411	2.530	2.553	7.593	101	.04432	310.3	14.10	7.110	.2600	47.03	49.01	73.25
22	.002487	17.41	12.11	.3999	.2411	2.639	2.664	7.944	102	.04577	320.4	14.12	7.341	.2606	48.57	50.63	75.11
23	.002595	18.17	12.13	.4172	.2412	2.753	2.780	8.300	103	.04727	330.9	14.15	7.579	.2613	50.16	52.31	77.03
24	.002707	18.95	12.16	.4352	.2412	2.872	2.901	8.661	104	.04881	341.6	14.17	7.827	.2620	51.78	54.02	78.98
25	0.002821	19.74	12.19	0.4535	0.2413	2.993	3.025	9.025	105	0.05038	352.7	14.20	8.080	0.2627	53.46	55.79	80.99
26	.002943	20.60	12.21	.4731	.2413	3.122	3.157	9.397	106	.05202	364.1	14.22	8.342	.2634	55.19	57.62	83.06
27	.003066	21.46	12.24	.4930	.2414	3.253	3.291	9.771	107	.05371	376.0	14.25	8.612	.2642	56.99	59.52	85.20
28	.003195	22.37	12.26	.5137	.2414	3.390	3.430	10.15	108	.05544	388.1	14.27	8.890	.2650	58.82	61.46	87.38
29	.003329	23.31	12.29	.5353	.2415	3.532	3.576	10.54	109	.05723	400.6	14.30	9.175	.2658	60.73	63.47	89.63
30	0.003469	24.28	12.31	0.5577	0.2416	3.681	3.727	10.93	110	0.05908	413.6	14.32	9.473	0.2666	62.68	65.55	91.95
31	.003615	25.30	12.34	.5812	.2416	3.835	3.886	11.33	111	.06097	426.8	14.35	9.775	.2674	64.69	67.67	94.31
32	.003762	26.33	12.36	.6046	.2417	3.991	4.047	11.73	112	.06294	440.6	14.37	10.09	.2683	66.77	69.88	96.76
33	.003920	27.44	12.39	.6300	.2418	4.159	4.219	12.14	113	.06497	454.8	14.40	10.41	.2692	68.93	72.16	99.28
34	.004082	28.57	12.41	.6560	.2418	4.331	4.395	12.56	114	.06705	469.4	14.42	10.75	.2702	71.14	74.50	101.86
35	0.004248	29.74	12.44	0.6829	0.2419	4.507	4.576	12.98	115	0.06920	484.4	14.45	11.09	0.2711	73.42	76.92	104.52
36	.004423	30.96	12.46	.7110	.2420	4.693	4.767	13.41	116	.07143	500.0	14.47	11.44	.2721	75.79	79.43	107.27
37	.004604	32.23	12.49	.7398	.2421	4.885	4.963	13.84	117	.07372	516.0	14.50	11.81	.2732	78.21	82.00	110.08
38	.004790	33.53	12.51	.7699	.2422	5.083	5.166	14.29	118	.07606	532.4	14.52	12.19	.2742	80.70	84.64	112.96
39	.004983	34.88	12.54	.8007	.2422	5.287	5.376	14.74	119	.07847	549.3	14.55	12.58	.2753	83.26	87.36	115.92

*The Trane Co. Member of Board of Consulting and Contributing Editors. Copyright, 1940, by William Goodman. Continued on next page.
(Tabulations for 22 in., 23 in., 24 in., 25 in., 26 in., 27 in., 28 in. and 29 in. were published in July, August, September, October, November and December, 1939, and March and April, 1940.)

Properties of Mixtures of Air and Saturated Water Vapor—(Continued)

Barometric Pressure 30 In. of Mercury

All tabulated values (except temperatures and pressures) are quantities per pound of dry air in the mixture.

Temp Deg Fahr	Absolute Humidity		Volume		Humid Specific Heat	1061*w*	Enthalpy (Heat Content)		Temp Deg Fahr	Absolute Humidity		Volume		Humid Specific Heat	1061*w*	Enthalpy (Heat Content)	
	Pounds	Grains	Dry Air Cu Ft	Volume Increase of Humid Air Per Cent			Water Vapor Btu	Air-Vapor Mixture Btu		Pounds	Grains	Dry Air Cu Ft	Volume Increase of Humid Air Per Cent			Water Vapor Btu	Air-Vapor Mixture Btu
t	*w*	*w*	v_D		c_p		h_v	h	*t*	*w*	*w*	v_D		c_p		h_v	h
1	2	3	4	5	6	7	8	9	1	2	3	4	5	6	7	8	9
120	0.08100	567.0	14.57	12.98	0.2765	85.94	90.21	119.01	160	0.2971	2079.9	15.58	47.43	0.3737	315.25	335.82	374.22
121	.08359	585.2	14.60	13.39	.2776	88.69	93.13	122.17	161	.3078	2154.8	15.60	49.13	.3785	326.61	348.03	386.67
122	.08623	603.6	14.62	13.82	.2788	91.49	96.10	125.38	162	.3191	2233.4	15.63	50.92	.3836	338.52	360.86	399.74
123	.08900	623.0	14.65	14.26	.2801	94.43	99.23	128.75	163	.3307	2315.0	15.65	52.77	.3888	350.89	374.18	413.80
124	.09183	642.8	14.67	14.71	.2813	97.44	102.42	132.18	164	.3430	2400.8	15.68	54.72	.3943	363.89	388.17	427.53
125	0.09477	663.4	14.70	15.18	0.2827	100.56	105.75	135.75	165	0.3558	2490.3	15.70	56.76	0.4001	377.46	402.79	442.39
126	.09781	684.6	14.72	15.66	.2840	103.77	109.17	139.41	166	.3691	2583.9	15.73	58.90	.4061	391.65	418.08	457.92
127	.1009	706.6	14.75	16.16	.2854	107.10	112.71	143.19	167	.3833	2682.9	15.75	61.13	.4125	406.65	434.25	474.33
128	.1042	729.1	14.77	16.68	.2869	110.51	116.35	147.07	168	.3981	2786.8	15.78	63.48	.4192	422.41	451.23	491.55
129	.1075	752.5	14.80	17.22	.2884	114.06	120.12	151.08	169	.4136	2894.9	15.81	65.84	.4261	438.79	468.89	509.45
130	0.1110	777.1	14.82	17.77	0.2900	117.78	124.10	155.30	170	0.4299	3009.2	15.83	68.53	0.4335	456.10	487.57	528.37
131	.1146	801.9	14.85	18.33	.2916	121.55	128.11	159.55	171	.4470	3129.0	15.86	71.25	.4412	474.27	507.17	548.21
132	.1182	827.1	14.87	18.92	.2932	125.36	132.17	163.85	172	.4651	3255.8	15.88	74.13	.4493	493.48	527.90	569.18
133	.1220	853.9	14.90	19.52	.2949	129.42	136.51	168.43	173	.4843	3389.9	15.91	77.18	.4579	513.81	549.84	591.36
134	.1259	881.4	14.93	20.15	.2967	133.60	140.97	173.13	174	.5044	3531.0	15.93	80.37	.4670	535.20	572.93	614.69
135	0.1300	909.7	14.95	20.80	0.2985	137.88	145.53	177.93	175	0.5255	3678.6	15.96	83.72	0.4765	557.58	597.10	639.10
136	.1341	938.9	14.98	21.47	.3004	142.31	150.27	182.91	176	.5480	3836.2	15.98	87.29	.4866	581.46	622.89	665.13
137	.1385	969.4	15.00	22.16	.3023	146.94	155.22	188.10	177	.5719	4003.2	16.01	91.09	.4974	606.76	650.23	692.71
138	.1430	1001.3	15.03	22.88	.3044	151.77	160.38	193.50	178	.5971	4179.8	16.03	95.09	.5087	633.54	679.16	721.88
139	.1477	1033.6	15.05	23.62	.3064	156.66	165.60	198.96	179	.6240	4368.3	16.06	99.37	.5208	662.11	709.97	752.93
140	0.1524	1067.1	15.08	24.38	0.3086	161.74	171.03	204.63	180	0.6529	4570.4	16.08	104.0	0.5338	692.75	743.09	786.29
141	.1574	1101.6	15.10	25.17	.3108	166.97	176.63	210.47	181	.6834	4784.0	16.11	108.8	.5475	725.12	778.09	821.53
142	.1626	1138.3	15.13	26.00	.3132	172.54	182.59	216.67	182	.7163	5014.4	16.13	114.0	.5624	760.04	815.84	859.52
143	.1679	1175.0	15.15	26.85	.3155	178.10	188.54	222.86	183	.7516	5261.3	16.16	119.6	.5782	797.46	856.31	900.23
144	.1734	1213.5	15.18	27.73	.3180	183.93	194.79	229.35	184	.7893	5524.8	16.18	125.6	.5952	837.39	899.51	943.67
145	0.1791	1253.6	15.20	28.65	0.3206	190.01	201.32	236.12	185	0.8299	5809.0	16.21	132.0	0.6134	880.48	946.12	990.52
146	.1851	1295.8	15.23	29.59	.3233	196.40	208.16	243.20	186	0.8733	6112.8	16.23	138.9	.6330	926.52	995.94	1040.6
147	.1913	1338.9	15.25	30.57	.3261	202.94	215.16	250.44	187	0.9203	6442.0	16.26	146.4	.6541	976.42	1050.0	1094.8
148	.1977	1383.6	15.28	31.59	.3290	209.72	222.43	257.95	188	0.9717	6801.8	16.28	154.5	.6773	1031.0	1109.0	1154.1
149	.2043	1429.8	15.30	32.64	.3319	216.71	229.92	265.68	189	1.028	7194.6	16.31	163.4	.7025	1090.5	1173.4	1218.8
150	0.2112	1478.3	15.33	33.75	0.3350	224.07	237.82	273.82	190	1.089	7619.5	16.33	173.0	0.7298	1154.9	1243.1	1288.7
151	.2183	1528.4	15.35	34.89	.3383	231.66	245.96	282.20	191	1.155	8087.1	16.36	183.6	.7599	1225.8	1319.8	1365.7
152	.2255	1578.6	15.38	36.06	.3415	239.27	254.13	290.61	192	1.229	8603.0	16.38	195.3	.7931	1304.0	1404.5	1450.6
153	.2335	1634.4	15.40	37.30	.3451	247.73	263.21	299.93	193	1.311	9177.7	16.41	208.3	.8300	1391.1	1498.9	1545.2
154	.2415	1690.6	15.43	38.57	.3487	256.24	272.35	309.31	194	1.402	9811.9	16.43	222.7	.8708	1487.2	1603.0	1649.5
155	0.2499	1749.4	15.45	39.91	0.3525	265.15	281.92	319.12	195	1.503	10,522	16.46	238.8	0.9164	1594.9	1719.7	1766.5
156	.2586	1810.1	15.48	41.30	.3564	274.36	291.85	329.29	196	1.617	11,320	16.48	256.9	0.9677	1715.8	1850.7	1897.8
157	.2675	1872.4	15.50	42.73	.3604	283.80	301.99	339.67	197	1.747	12,230	16.51	277.4	1.026	1853.7	1999.9	2047.2
158	.2771	1940.0	15.53	44.23	.3647	294.05	313.00	350.92	198	1.895	13,265	16.53	300.8	1.093	2010.6	2170.0	2217.5
159	.2869	2008.0	15.55	45.79	.3691	304.36	324.09	362.25	199	2.031	14,218	16.56	322.4	1.154	2155.1	2326.7	2374.5
									200	2.264	15,847	16.58	359.2	1.259	2402.0	2594.2	2642.2

[*Concluded from p.* 310]

horizontal pipe position welds. For horizontal pipe position welds each layer shall be started at the top center line and progress downward to the bottom center line. It shall then be restarted (exercising proper precautions to insure fusion at this point) at the top center line and progress downward, on opposite side, to bottom center line where it meets and is fused with previous deposit.

Cleaning of Weld: Each layer shall be wire brushed for removal of loose scale before laying down next successive layer of welding.

Short Time Stress Relief

A method of stress relief which offers much promise has been employed to a limited extent. For want of a better name it has been designated as "short time stress relief" to distinguish it from the other methods. In this procedure, after the weld has cooled to say 600 F, the pipe weld and the necessary zone of adjacent base metal is heated uniformly with one or more torches to a temperature range of 1400-1500 F. This is on the basis that this is the closest approach to ideal annealing conditions obtainable in field work. When this temperature is reached, as determined by pyrometers, the joint is immediately wrapped with asbestos paper or blankets and any opening plugged up to eliminate interior drafts. This provides slow cooling, which is essential. Tests have shown that temperature difference between the outside and inside of a pipe will be about 50 F but never any greater than 100 F. By utilizing two or more torches, depending on size and thickness, equipped with multiple flame tips if necessary, it is possible to achieve a very uniform heating. This method was first used on a plain carbon steel piping system on both shop and field welding and tests of joints treated in this manner showed greatly refined grain structure and high ductilities when subjected to bending. All but one of the field tests included in the studies discussed here were stress relieved by this method and the results by present standard practices were no better than those by short time stress relief.

Table 1—Size of Welding Tip

Pipe Wall Thickness, In.	Use Tips Consuming Following Volume of Acetylene, Cu Ft per Hr, Approx.
1/8- 1/4	12-36
1/8- 1/2	36-60
1/4- 3/4	30-100
1/8-1 1/4	50-175
1 1/4-2	65-175

Note: In general larger tips of a range (greater acetylene flows) will be used for rolling welds while smaller tips (lesser acetylene flows) will be used for position welds.

Determining Power Requirements for Refrigeration Compressors

By Richard J. Panlener*

TO determine or to check the power requirements for refrigeration compressors, many engineers prefer to use equation 1 for the actual indicated horsepower, *aihp*, to which they add the friction horsepower, *fhp*, to obtain the brake horsepower, *bhp*, at the compressor wheel.

$$aihp = \frac{PLAN}{33{,}000} \quad \text{.....[1]}$$

where $P = mep_c$ or the mean effective pressure, lb per sq in.;
L = length of the compressor stroke, ft;
A = area of the piston, sq in.;
N = number of compression strokes per min;
33,000 = constant to convert work in ft-lb per min to hp.

When the actual indicator cards are available for checking purposes, it is possible to determine the mean effective pressure by multiplying the card area as determined by a planimeter by the spring scale used in the indicator and dividing by the card length in inches. However, checks are frequently desired when indicator cards are not obtainable and it is up to the engineer to get as accurate a value of mean effective pressure as possible.

There are three equations which may be used in calculating values of mep_o, which is the mean effective pressure of an ideal compressor without clearance volume. In order to convert mep_o into values of mep_c for equation 1, it is necessary to multiply by E_c, the volumetric efficiency due to clearance, or

$$mep_c = mep_o \times E_c \quad \text{.....[2]}$$

The equations for mep_o are

$$mep_o = \frac{n}{n-1} P_1 \left[\left(\frac{P_2}{P_1} \right)^{\frac{n-1}{n}} - 1 \right] \quad \text{.....[3]}$$

$$= \frac{nR\,(t_2 - t_1)}{144\,(n-1)V_1} \quad \text{.....[4]}$$

$$= 5.399\,\frac{H_2 - H_1}{V_1} \quad \text{.....[5]}$$

where mep_o = mean effective pressure without compressor clearance, lb per sq in.;
n = coefficient of compression process;
P_2 = refrigerant discharge or condensing pressure, lb per sq in. absolute;
P_1 = refrigerant suction pressure, lb per sq in. absolute;
R = gas constant;
t_2 = discharge gas temperature, F;
t_1 = suction gas temperature, F;
V_1 = specific volume of the refrigerant suction gas, cu ft per lb;
H_2 = heat content in Btu per lb of the gas at discharge conditions of pressure and temperature;
H_1 = heat content in Btu per lb of the gas at suction conditions of pressure and temperature.

The above equations are theoretically derived and apply along with their constants, 144 and 5.399 to all gases.

*The Vilter Mfg. Co.

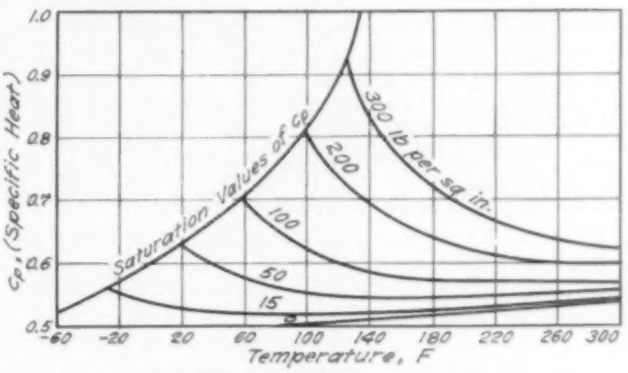


Fig. 1—Specific heat of ammonia vapor at constant pressure

To illustrate the comparative values of equations 3, 4 and 5, an ammonia compressor operating at 20 lb per sq in. ga suction and 175 lb per sq in. ga discharge and having a 91.9 per cent volumetric efficiency due to clearance was used as the basis in determining the following figures. Conditions were taken both with saturated suction and with 20 F superheated suction gas, superheat being obtained in the evaporator. The *aihp* per ton was determined by dividing the total compressor *aihp* by the compressor capacity in tons. These figures are given in Table 1.

Table 1

Equation Number	Saturated Suction		20 F suction superheat	
	mep_c	*aihp* per ton	mep_c	*aihp* per ton
3	66.2	1.301	66.2	1.346
4	68.4	1.344	71.2	1.447
5	66.0	1.298	66.1	1.343

It is obvious from Table 1 that there can be disconcerting variations in the calculations of compressor power requirements and it remains for the engineer to deter-

[*Concluded at bottom of next page*]

Summary of

Determining Power Requirements for Refrigeration Compressors

By Richard J. Panlener

To determine or check power requirements of refrigeration compressors, many engineers use the equation for actual indicated horsepower, *aihp*, to which is added the friction horsepower to obtain the brake horsepower at the compressor wheel. The equation for *aihp* is: $aihp = (PLAN) \div 33{,}000$, where P is mean effective pressure in lb per sq in., L is length of compressor stroke in ft, A is area of piston in sq in., N is number of compression strokes per min, and 33,000 is a constant . . . . . When indicator cards are available, it is possible to determine the mean effective pressure. When cards are not available, mean effective pressure may be calculated by one of three equations given here. These are theoretically derived, and there are disconcerting variations due to the question of the proper values of n and of R (the gas constant) which should be used in these equations

Booklets, Reports and Papers

Deaerator Standards

The Heat Exchange Institute, 90 West St., New York, N. Y., has published a new standard to complement its series on surface and barometric condensers, and steam jet ejector standards.

The new publication is entitled Standards of the Deaerator and Deaerating Heater Section and contains recommendations on nomenclature, definitions, construction, ratings, accessories, and a typical specification. This specification feature has been planned to assist the designing engineer in furnishing the information necessary for construction of the proper unit.

The price of this 12 p., 8½x11 in. publication is 75c per copy, payable in advance, from the institute.

Procedure Under Government Contracts

The Fidelity and Deposit Co. of Maryland, Baltimore, Md., has issued the third edition of a 78 p. booklet entitled Matters of Procedure Under Government Contracts, by O. R. McGuire. It is available upon request.

The booklet covers such things as the bid, the contract, contracting agencies of the United States, contracts with government corporations, settlement of claims under government contracts, and government sales.

Fuel Oil Standard

Copies of the fifth edition of Commercial Standard CS12-40 on fuel oils are available from the Superintendent of Documents, Washington, D. C., for 5 cents each. This standard supersedes CS12-38 and was accepted by the industry as its standard of practice for new production beginning January 5 of this year.

Directory of Service Organizations

A directory of independent service organizations in heating, refrigeration and air conditioning has recently been published by the research department of Industrial Training Institute, 2130-2158 Lawrence Ave., Chicago, Ill., and is available from the institute for $4.00 per copy. It comprises a spirally bound, paper covered, planographed booklet of 219 pages, 8¼ x 10¾ in. in size.

Information is summarized for 2000 organizations and the work in which they specialize. The firms are listed by state and city, and in addition to names and addresses information is given on number of service men employed; name of manager; whether the organization is equipped to handle service work in various classifications; whether parts and supplies are sold by the organization; whether flat or hourly rates are charged; percentage of refrigeration service which is domestic, commercial and summer air conditioning; whether the firm specializes on old or new equipment; whether it is equipped to furnish complete engineering service; types of heating work done; and manufacturers and firms for whom the organization does service work.

Such service organizations employ an average of 3.55 service men in summer and 3.12 in winter, according to the analysis.

Index to ASTM Standards

The American Society for Testing Materials, 260 N. Broad St., Philadelphia, Pa., has published a 152 page, 6 x 9 in., paper covered Index to ASTM Standards, Including Tentative Standards. It may be obtained free of charge on written request to ASTM headquarters.

All items are listed in the index under appropriate key words, according to the particular subject, and as a convenience a list is given of the specifications and tests in numerical sequence of their serial designations.

Book Reviews

New Edition of Arc Welding Handbook

[Procedure Handbook of Arc Welding Design and Practice. 6th ed. 1940. 1117 + x pp., 5¾ x 9 in., semi-flexible simulated leather binding. Published by The Lincoln Electric Co., 12818 Coit Rd., Cleveland, Ohio. Price, $1.50 in United States, $2.00 elsewhere.]

The new edition of this useful handbook on arc welding design and practice is encyclopedic in scope, concisely written and profusely illustrated. It contains data of interest to engineers, designers, piping and pipe line contractors, architects, draftsmen, steel fabricators and erectors, foremen, cost estimators, maintenance managers, job welders, repair shops and students of welding.

The material is divided into eight sections on welding methods and equipment; technique of welding; procedures, speeds and costs for welding mild steel; structure and properties of weld metal; weldability of metals; designing for arc welded steel construction of machinery; designing for arc welded structures; and typical applications of arc welding in manufacturing, construction and maintenance.

Determining Power Requirements—

[*Concluded from preceding page*]

mine the equation which is most reliable. These discrepancies are due to the selection of the values to be substituted in the equations for R and n. The value n depends upon the refrigerant since it is a modified value of the ratio c_p, which is the specific heat of the refrigerant at constant pressure, to c_v, which is the specific heat of the refrigerant gas at constant volume. However, n also depends somewhat upon the design and operation of the compressor.

c_p also varies with the pressure and temperature; Fig. 1 shows this variation for ammonia. This curve illustrates that c_p cannot be considered as even approximately constant and hence any value which is based upon a constant value of c_p will be in error.

This assumption of a constant value of n inevitably causes inconsistencies in equations 3 and 4. Equation 5 necessitates obtaining the heat content values direct from the Mollier chart and yields values which check consistently with operating conditions.

Table 1 also indicates that mep_c from equation 3 is always the same (for a given suction and discharge pressure) regardless of the condition of the temperature of the suction gas; equation 4 takes into account saturated or superheated conditions alike. However, equation 5 covers all conditions, even a wet suction gas condition, and is by far the most accurate as well as the easiest to use.

These discrepancies are fundamentally due to the fact that equations 3 and 4 are based on the assumption that the refrigerant behaves like a perfect gas, which it of course does not do, and equation 5 is not based on this assumption. When using equation 5, values of total heat obtained by experiment are used. Results obtained from equations 3 and 4 are approximate, whereas those obtained from equation 5 are exact.

Heating · Piping and Air Conditioning

AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

Journal Section

★ CONTENTS ★

MAY, 1940

Reactions of 745 Clerks to Summer Air Conditioning, by W. J. McConnell and M. Spiegelman 317

Fever Therapy Locally Induced by Conditioned Air, by Murray B. Ferderber, F. C. Houghten and Carl Gutberlet..... 323

Dynamic and Thermal Behavior of Water Drops in Evaporative Cooling Processes, by H. B. Nottage and L. M. K. Boelter..... 326

Summer Meeting Arrangements Committee... 333

Washington Wants to See You in June..... 334

Local Chapter Reports..... 336

Candidates for Membership..... 340

Candidates Elected 342

BULLETIN BOARD

RANDOM NOTES

Since January 1 over 200 candidates have been elected to Society membership. . . . There are 8528 copies of the 1940 Guide now in use. . . . Council held its quarterly meeting April 15, in Chicago and authorized a general meeting of the Society this Fall. . . . The Society is now sponsoring 22 Research investigations, 10 at the Pittsburgh Laboratory and the others in cooperating colleges.

* * *

READY — SET — GO

On to Washington, June 17-19, for the Semi-Annual Meeting. . . . The Chapter Members have arranged a mighty fine program for your entertainment. . . . Weather records for the period of the meeting show a delightful climate in Washington at that time of the year. . . . Local members hope that tall stories about their summer weather will not cause any member to miss this splendid meeting of friends and associates.

COMMITTEE ON RESEARCH

A. E. STACEY, JR., *Chairman*

C.-E. A. WINSLOW, *Vice-Chairman* — F. C. HOUGHTEN, *Director*

J. H. WALKER, *Technical Adviser* — A. C. FIELDNER, *Ex-Officio Member*

One Year

M. K. FAHNESTOCK — W. L. FLEISHER — R. J. TENKONOHY

T. H. URDAHL — B. M. WOODS

Two Years			*Three Years*		
R. E. DALY	W. A. DANIELSON	H. J. ROSE	PHILIP DRINKER	AXEL MARIN	A. E. STACEY, JR.
C. TASKER	C.-E. A. WINSLOW		J. H. VAN ALSBURG		J. H. WALKER

Executive Committee

A. E. STACEY, JR., *Chairman*

M. K. FAHNESTOCK — T. H. URDAHL — C.-E. A. WINSLOW — B. M. WOODS

Technical Advisory Committees

1. *Sensations of Comfort:* C. Tasker*, *Chairman;* C. R. Bellamy, Thomas Chester, Elliott Harrington, W. S. Kilpatrick, Dr. W. J. McConnell, A. B. Newton, B. F. Raber, L. C. Soule.

2. *Physiological Reactions:* C.-E. A. Winslow*, *Chairman;* Dr. T. Bedford, Dr. E. F. DuBois, Dr. M. B. Ferderber, E. P. Heckel, John Howatt, Dr. R. W. Keeton, C. S. Leopold, André Missenard, Dr. R. R. Sayers, Dr. Charles Sheard, C. Tasker*.

3. *Treatment of Disease:* Dr. M. B. Ferderber, *Chairman;* Dr. C. J. Barone, Dr. A. R. Behnke, Dr. B. Z. Cashman, W. L. Fleisher*, Dr. T. L. Hazlett, C. S. Leopold, Dr. C. D. Selby, Dr. A. W. Sherrill, Dr. H. F. Smyth, Dr. C. S. Stephenson, Dr. B. L. Vosburgh.

4. *Air Conditioning in Industry:* W. L. Fleisher*, *Chairman;* Philip Drinker, Dr. Leonard Greenburg, H. P. Greenwald, A. M. Kinney, J. W. Kreuttner, L. L. Lewis, H. B. Matzen, Dr. W. J. McConnell, Dr. C. P. McCord, P. A. McKittrick, Dr. R. R. Sayers, Dr. Charles Sheard, C. Tasker*, R. M. Watt, Jr.

5. *Air Pollution and Purification:* C.-E. A. Winslow*, *General Chairman.*

5a. *Air Pollution:* H. B. Meller, *Chairman,* F. A. Chambers, Philip Drinker*, J. S. Owens, Sol Pincus, H. J. Rose*, R. J. Tenkonohy*, E. C. Webb, E. H. Whitlock.

5b. *Removal Atmospheric Impurities:* Dr. Leonard Greenburg, *Chairman,* R. S. Dill, Theodore Hatch, L. R. Koller, F. H. Munkelt, G. W. Penney, Dr. E. B. Phelps, F. B. Rowley, C. Tasker*, W. O. Vedder, Jack Waggoner, R. P. Warren, W. F. Wells, Dr. Rene Wiener.

6. *Radiation and Comfort:* J. C. Fitts, *Chairman;* A. H. Barker, L. M. K. Boelter, R. E. Daly*, E. R. Gurney, L. N. Hunter, A. P. Kratz, C. S. Leopold, D. W. Nelson, W. J. Olvany, G. W. Penney, W. R. Rhoton, C.-E. A. Winslow.*

7. *Instruments:* D. W. Nelson, *Chairman;* F. R. Bichowsky, L. M. K. Boelter, R. S. Dill, M. K. Fahnestock*, A. P. Gagge, J. A. Goff, F. W. Reichelderfer, G. L. Tuve, C. P. Yaglou.

8. *Weather Design Conditions:* T. H. Urdahl*, *Chairman:* J. C. Albright, P. D. Close, John Everetts, Jr., C. M. Humphreys, J. B. Kincer, O. A. Kinzer, J. W. O'Neill, F. W. Reichelderfer.

9. *Radiation with Gravity Air Circulation:* M. K. Fahnestock*, *Chairman;* R. E. Daly*, R. S. Dill, A. G. Dixon, H. F. Hutzel, J. P. Magos, J. W. McElgin, J. F. McIntire, T. A. Novotney, W. A. Rowe.

10. *Heat Transfer of Finned Tubes with Forced Air Circulation:* W. E. Heibel, *Chairman;* William Goodman, H. F. Hutzel, Ferdinand Jehle, S. F. Nicoll, R. H. Norris, L. P. Saunders, R. J. Tenkonohy*, G. L. Tuve, C. F. Wood.

11. *Cooling Load in Summer Air Conditioning:* C. M. Ashley, *Chairman;* John Everetts, Jr., F. H. Faust, M. G. Kershaw, A. E. Knapp, C. S. Leopold, L. S. Morse, R. M. Strikeleather, J. H. Walker.*

12. *Solid Fuels:* R. A. Sherman, *Chairman;* C. E. Bronson, W. A. Danielson*, R. S. Dill, H. N. Eavenson, A. C. Fieldner, L. N. Hunter, A. J. Johnson, R. E. Kerr, H. K. Kugel, F. L. Meyer, Percy Nicholls, V. F. Parry, H. J. Rose*, L. E. Seeley, C. E. Shaffer, C. Tasker*, E. C. Webb.

13. *Summer Air Conditioning for Residences:* M. K. Fahnestock*, *Chairman;* C. F. Boester, E. A. Brandt, John Everetts, Jr., Elliott Harrington, H. F. Hutzel, J. A. Kiesling, E. D. Milener, K. W. Miller, F. G. Sedgwick, J. H Walker*.

14. *Air Distribution and Air Friction:* J. H. Van Alsburg*, *Chairman;* S. H. Downs, A. E. Hershey, R. D. Madison, L. G. Miller, D. W. Nelson, C. H. Randolph, D. J. Stewart, M. C. Stuart, Ernest Szekely, R. J. Tenkonohy*, G. L. Tuve.

15. *Heat Requirements of Buildings:* P. D. Close, *Chairman;* E. K. Campbell, J. F. S. Collins, Jr., E. F. Dawson, W. H. Driscoll, H. M. Hart, E. C. Lloyd, H. H. Mather, C. H. Pesterfield, F. B. Rowley, R. K. Thulman, J. H. Walker*.

16. *Air Conditioning Requirements of Glass:* M. L. Carr, *Chairman;* F. L. Bishop, W. A. Danielson*, H. C. Dickinson, J. D. Edwards, J. E. Frazier, S. O. Hall, E. H. Hobbie, C. L. Kribs, Jr., Axel Marin*, R. A. Miller, F. W. Parkinson, J. H. Plummer, W. C. Randall, L. T. Sherwood, J. T. Staples, G. B. Watkins, F. C. Weinert.

17. *Insulation:* R. T. Miller, *Chairman;* E. A. Allcut, R. E. Backstrom, Wharton Clay, R. E. Daly*, W. A. Danielson*, H. C. Dickinson, J. D. Edwards, W. V. Hukill, E. C. Lloyd, Paul McDermott, E. W. McMullen, W. T. Miller, E. R. Queer, F. B. Rowley, W. S. Steele, J. H. Waggoner, G. B. Wilkes.

18. *Sound Control:* J. S. Parkinson, *Chairman;* E. L. Anderson, C. M. Ashley, A. L. Kimball, V. O. Knudsen, R. D. Madison, R. F. Norris, C. H. Randolph, A. E. Stacey, Jr.*, G. T. Stanton, A. G. Sutcliffe, R. M. Watt, Jr.

19. *Cooling Towers, Evaporative Condensers and Spray Ponds:* B. M. Woods*, *Chairman;* J. C. Albright, W. W. Cockins, S. C. Coey, E. H. Hyde, E. H. Kendall, S. R. Lewis, J. Lichtenstein, H. B. Nottage, J. F. Park, E. T. Selig, Jr., E. H. Taze.

20. *Psychrometry:* F. R. Bichowsky, *Chairman;* D. B. Brooks, W. H. Carrier, H. C. Dickinson, A. W. Gauger, J. A. Goff, William Goodman, A. M. Greene, Jr., L. P. Harrison, F. G. Keyes, A. P. Kratz, D. M. Little, Axel Marin*, D. W. Nelson, W. M. Sawdon, F. O. Urban.

21. *Corrosion:* A. R. Mumford, *Chairman;* H. E. Adams, J. F. Barkley, L. F. Collins, W. H. Driscoll, T. J. Finnegan, W. Z. Friend, R. R. Seeber, E. T. Selig, Jr., F. N. Speller, J. H. Walker*.

22. *Flow of Fluids Through Pipes and Fittings:* S. R. Lewis, *Chairman;* L. A. Cherry, G. C. Davis, T. M. Dugan, Earle W. Gray, R. T. Kern, H. A. Lockhart, Axel Marin*, R. F. Taylor, E. L. Weber.

*Member of Committee on Research.

Reactions of 745 Clerks to Summer Air Conditioning

By W. J. McConnell,* B.S., M.D., and M. Spiegelman,** M.E., M.B.A.
New York, N. Y.

Purpose of Study

THIS study was undertaken primarily for the purpose of ascertaining the cooling requirements for summer air conditioning in the new unit of the home office buildings of the Metropolitan Life Insurance Co. It was suggested by the Research Technical Advisory Committee on Sensations of Comfort of the American Society of Heating and Ventilating Engineers, whose interest was essentially to obtain *conclusive information on the indoor requirements for different geographical regions of the country.* The study was conducted during the summer of 1938.

The first studies on the cooling requirements for air conditioning were made by the Society in its Research Laboratory located in Pittsburgh, Pa. Later, other studies were made in cooperation with the Society in Texas and Ontario, with a limited number of college students as subjects.[1, 2] In order to learn whether the reactions of the college students were typical of persons of both sexes in the occupational ages as they went about their daily tasks, another study was made in an air conditioned office in Minneapolis with 275 employees.[3]

The present study covers 745 clerks (172 men, 573 women) on seven floors of the new unit of the home office of the Metropolitan Life Insurance Co. Although the ages of the clerks were not ascertained, a variation between 17 and 65 years is possible.

Method of Collecting Data

The clerks on the floors selected for study were asked in a circular, shown in Fig. 1, to cooperate on a voluntary basis. In this circular, a description was given of the purpose of the study and the means by which it would be carried out. The perfect cooperation which was secured eliminated at least one source of bias, namely, that which may arise from the inclusion only of those persons careful of their health.

The period of observation extended from July 6 to September 30, 1938. Every morning each clerk received a questionnaire card which was collected the following day. For purposes of statistical control, section heads were asked to return the cards daily for clerks absent. A copy of the card used is shown in Fig. 2. In addition to name, section, date, and sex, the clerk was asked to place a check in the appropriate column describing his or her reaction at a stated time of day. In the relatively few cases where a clerk made out the card incompletely, she was asked to recall her reaction to the best of her ability. Although the card asked for the reaction of the clerk to conditions outside of the working hours, tabulations were made only of the reactions during working hours, namely, 11 a.m., 3 p.m. and 4 p.m. Special comments noted at the bottom of the cards were studied daily by the engineers in charge of the air conditioning equipment.

Air Conditioning Study

The Company is making a study to determine the conditions of temperature and humidity in the office under which our people are most comfortable. The most important requirement of the study is the collection of facts showing the physical reactions of a large number of people from day to day. Your Section is one in which the study will be conducted. We are, therefore, asking your assistance to the extent of filling in daily the information called for on a form card, a sample of which is attached. The Company believes that everyone will wish to cooperate in the study, but it should be distinctly understood that participation in it is entirely voluntary.

No special instructions for filling in the cards are necessary. Attention is called, however, to the last item where space is provided for general comments which will help in interpreting the record. Here you are asked to make note of any special conditions which may account for a feeling of discomfort in the air-conditioned offices, as for example, "severe warmth at 3 P.M. due to sun's rays"; "not feeling up to par"; "more than usual physical activity due to walking to and from files around 11 A.M."; "sitting too close to walls"; "feel a draught"; etc. Note should also be made here of a distinct feeling of discomfort at any other time of day, giving the time and a statement as to possible causes. If during the period of the study your location in the Section is changed, a record of that fact should be made in the space for general remarks.

Cards will be distributed each morning and collected the following morning.

Your recorded reactions will enable us to tabulate and analyze the group feelings. We cannot stress too much that a record of your personal feelings of warmth or chilliness, uninfluenced by comparison with others, and wholly free from personal bias, is what is needed to make the work of greatest value.

Your cooperation in this work will be a distinct contribution to the knowledge necessary for more satisfactory air conditioning.

Personnel Officer.

Fig. 1—Reproduction of circular describing study

*Director, Industrial Health Section, Metropolitan Life Insurance Co.
** Statistical Bureau, Metropolitan Life Insurance Co.

[1] ASHVE Research Report No. 1035—Comfort Standards for Summer Air Conditioning, by F. C. Houghten and Carl Gutberlet. (ASHVE Transactions, Vol. 42, 1936, p. 215.)

[2] ASHVE Research Report No. 1055—Cooling Requirements for Summer Comfort Air Conditioning, by F. C. Houghten, F. E. Giesecke, C. Tasker and Carl Gutberlet. (ASHVE Transactions, Vol. 43, 1937, p. 145.)

[3] ASHVE Research Report No. 1088—Summer Cooling Requirements for 275 Workers in an Air Conditioned Office, by A. B. Newton, F. C. Houghten, Carl Gutberlet and R. W. Qualley. (ASHVE Transactions, Vol. 44, 1938, p. 337.)

For presentation at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Washington, D. C., June, 1940.

RECORD OF PHYSICAL REACTIONS TO ATMOSPHERIC CONDITIONS
July, August, September 1938
METROPOLITAN LIFE INSURANCE COMPANY

Male ☐ Female ☐

Name.....
Section.....
Date.....

	Please Check Thus √ in Appropriate Column				
	Ideal	Chilliness		Warmth	
		Mild	Severe	Mild	Severe
1. Morning reaction to outdoor air on leaving home					
2. Reaction upon entering Section					
3. Reaction during working hours: 11 a.m.					
3. Reaction during working hours: 3 p.m.					
3. Reaction during working hours: 4 p.m.					
4. Reaction to outdoor air immediately after leaving building					
5. Continued reaction during evening					

6. General remarks

Fig. 2—Questionnaire card

Records of Physical Conditions

At first, the clerks were asked to designate on the card, by prescribed symbol, the area of the floor in which they were located. This step was discarded when the records of atmospheric conditions were found to show no appreciable variation in the different areas into which the floor was divided.

Continuous recording thermometers were installed to record the dry- and wet-bulb temperatures during the period in which the tests were conducted. In addition, wet-bulb and dry-bulb temperature readings were taken on each floor by means of a sling psychrometer every day at 11 a.m. and 3 p.m. For the locations in which the readings were taken on a typical floor, see Fig. 3. Outdoor readings were taken daily at 9 a.m., 11 a.m., and 3 p.m. A daily record was also kept of the maximum and minimum outdoor temperatures, together with the times at which they were noted.

In order to obtain more complete reaction data, the air conditions were varied to an appreciable extent both below and above the conditions usually prevailing. This, of course, had the effect of bringing more forcibly to the attention of the clerks the presence of uncomfortable conditions.

Method of Analysis

The daily cards from the divisions on each of the seven floors were sorted separately; first, according to sex, and then, according to reaction (ideal, mild chill, severe chill, mild warmth, and severe warmth) at 11 a.m., at 3 p.m. and at 4 p.m. For each division, the number reporting daily in each sex, reaction, and time category was then entered in a table on a line corresponding to the average of the effective temperatures observed in the various areas of the division at the time specified.

Effective temperature (ET) is an arbitrary index of the relative feeling of warmth or cold experienced by persons in response to temperature, humidity, and air motion, as developed and used by the ASHVE.

The upper panel of Table 1 shows, by way of example, the results of a tabulation of the cards of women according to their reactions at 11 a.m. on August 10. In the lower panel of the table, the numbers of each line corresponding to a specified effective temperature have been expressed as percentages of the total number on that line. That effective temperature for which the per cent ideal is highest is regarded as the optimum effective temperature for the day. In the case of this example, the highest per cent reporting ideal is found opposite effective temperatures in the range from 70.2 to 70.6 deg.

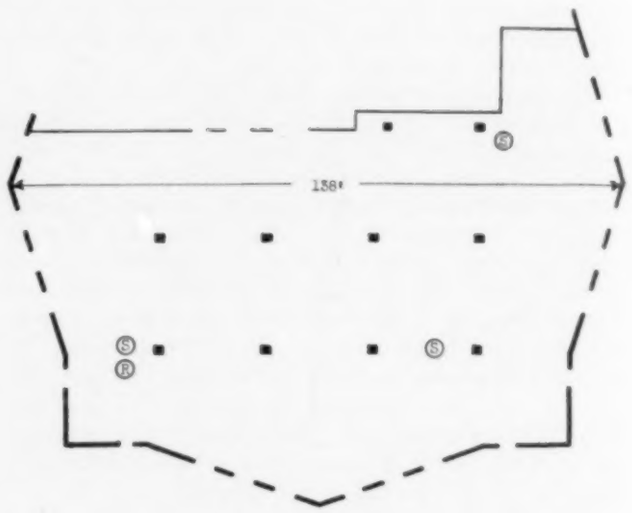
The daily records were consolidated into monthly records and finally into a summary for the whole period of observations.

Description of Results

Daily Record

For purposes of study, it was convenient to represent graphically the following data for each day during the period of observation (see Fig. 4):

1. Indoor effective temperatures
   a. optimum
   b. maximum
   c. minimum
2. Outdoor effective temperatures
   a. 9 a.m.
   b. mean of 9 a.m., 11 a.m. and 3 p.m.
   c. maximum
   d. minimum



(S) Indicates position of Sling Psychrometer
(R) Indicates position of Recorder

Fig. 3—Plan of one of the floors used in the study

It should be noted, first of all, that during the greater part of the period of observation the range between the maximum and minimum indoor effective temperatures was very limited. In 29 out of the 62 days of observation, the range was less than 3 F; it was greater than 5 F for only 6 days out of the total. For 27 out of the 62 days, the range from minimum to maximum was from 3 to 5 F.

As regards the daily range of indoor effective temperature, the period from July 20 to September 28 may be divided into two sub-periods. In the first, extending from July 20 to August 22, there were only two days when the daily range in the indoor effective temperature was as much as 3 deg. Thus, it is obvious that during this period there was little room for variation in reaction to changes in air conditions. During the second sub-period, from August 23 to September 28, except

Table 1—Tabulation of Reactions August 10, 1938, 11 a. m.

Effective Temperature Deg Fahr.	Women					
	All Conditions	Ideal	Chilliness		Warmth	
			Mild	Severe	Mild	Severe
	Number					
Total	472	313	18	3	127	11
69.8 – 70.2	83	63	9	3	8	—
70.2 – 70.6	18	16	1	—	1	—
70.6 – 71.0	62	45	1	—	16	—
71.0 – 71.4	227	146	7	—	66	8
71.4 – 71.8	82	43	—	—	36	3
	Per Cent					
Total	100.0	66.3	3.8	0.7	26.9	2.3
69.8 – 70.2	100.0	75.9	10.9	3.6	9.6	—
70.2 – 70.6	100.0	88.8	5.6	—	5.6	—
70.6 – 71.0	100.0	72.6	1.6	—	25.8	—
71.0 – 71.4	100.0	64.3	3.1	—	29.1	3.5
71.4 – 71.8	100.0	52.4	—	—	43.9	3.7

This table accounts for only 472 women out of a total of 573 present when the study was started. The difference between these two numbers arises principally from absences and from clerks on vacations. Some of the difference may also arise on account of clerks who left or who entered the employ of the company since the study was started.

for two days, the daily range from minimum to maximum indoor effective temperature was over 3 deg. In order to bring out more clearly the foregoing observations, the maximum and minimum daily indoor effective temperatures, as well as the daily optimum effective temperature, have been plotted in Fig. 4.

From a cursory inspection of Fig. 4, it is difficult to observe any obvious correspondence between optimum indoor effective temperature and outdoor effective temperature, whether at 9 a.m., mean of 9 a.m., 11 a.m. and 3 p.m., maximum, or minimum. However, an examination of the day-to-day changes, of which a total of 49 are possible,[4] shows that in only 13 instances were the changes in optimum effective temperature different in sign from the changes in the mean of the 9 a.m., 11 a.m., and 3 p.m. outdoor effective temperature. In only 24 out of the 49 possibilities were increases in mean outdoor temperature accompanied by increases in optimum indoor temperature, or decreases in outdoor temperature accompanied by decreases in optimum temperature. For the remaining 12 out of the 49 possibilities, there were no day-to-day changes in optimum indoor effective temperature.

[4]The five-day working week and intervening week-ends reduce the number of day-to-day changes possible to 49, although there was a total of 62 days of observation.

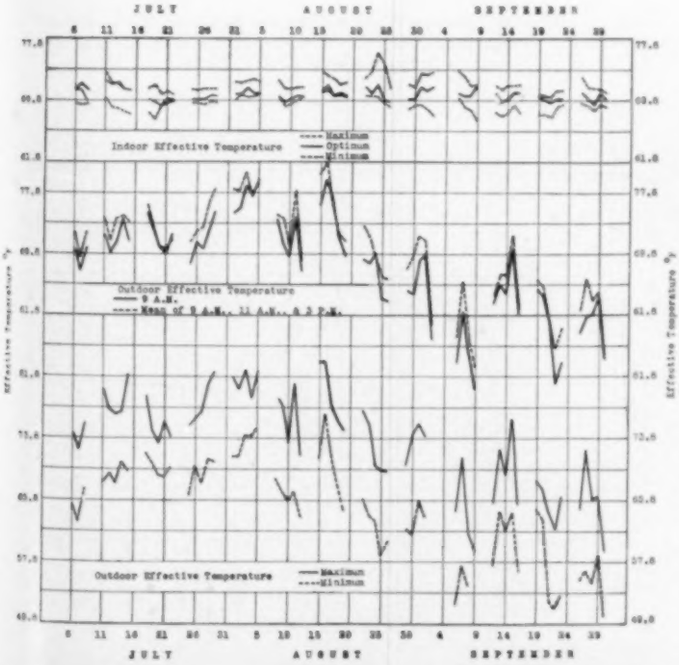


Fig. 4—Daily temperature log and optimum effective temperature for indoor air conditioning July, August and September, 1938

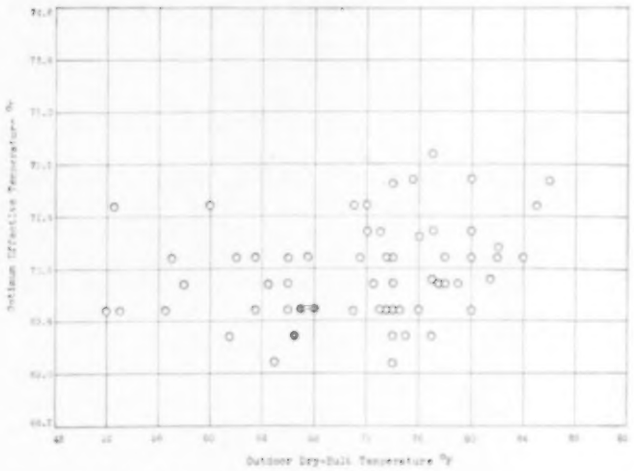


Fig. 5—Relation between daily outdoor dry-bulb temperature at 9 a. m. and optimum effective temperature July, August and September, 1938

A comparison of day-to-day changes in optimum effective temperature with the changes in 9 a.m. outdoor temperature is of special interest, for it indicates the extent to which the latter may be used as a gauge by which to adjust the air conditioning equipment daily for optimum conditions. Here it is found that in 14 out of the 49 possibilities, the optimum indoor temperature made a change from the previous day which was contrary to that made by the outdoor temperature; in 23 instances the changes were in the same direction, and in the remaining 12, the optimum temperature did not change from that of the previous day.

Relation Between Daily Outdoor Temperature and Indoor Optimum Effective Temperature

For purposes of investigating further the possibility of a relationship between daily outdoor temperatures and indoor optimum effective temperature, reference should be made to Figs. 5, 6, 7 and 8. In none of these figures will there be observed any definite correlation between optimum indoor effective temperature and outdoor dry-bulb temperatures, whether they be at 9 a.m., the mean of 9 a.m., 11 a.m., and 3 p.m., the maximum, or the minimum. This negative finding is not particularly surprising in view of the narrow range of the daily indoor effective temperatures. This limitation in the present study made it impossible to confirm the conclusion stated in a previous report,[5] namely, *that a relationship exists between the optimum effective temperature and the four daily weather conditions against which they are plotted.* The four daily weather conditions referred to in this quotation are outdoor maximum, minimum, and mean dry-bulb temperatures and the average of the outdoor mean dry-bulb temperature for a given day and the two previous days.

[5]Loc Cit. See Note 8.

Reaction Curves for Entire Period of Observation

Although the daily range in indoor effective temperatures was limited, the range over the entire period of observation was rather wide, covering the interval from 67.5 to 75.6 deg.

When the daily reports for the entire period were consolidated, the results shown in Fig. 9 are obtained. The curves in this figure are typical of the reactions of comfort, warmth and chilliness to variation in effective temperature. As is to be expected, with advance in effective temperature, the curve for *chilliness* falls off rapidly while that for *warmth* mounts sharply. The curve for comfort is hat-shaped and rises to a maximum in the interval 69.8 to 70.1 deg mean effective temperature, at which 66.2 per cent of the persons reporting over the entire period of observation noted an *ideal* reaction. Therefore, under the conditions of the present experiment, the interval 69.8 to 70.1 deg may be considered, on the whole, as the optimum effective temperature for summer air conditioning in the new unit of the home office of the Metropolitan Life Insurance Co. As a curiosity, it is observed that in this interval of temperature, the percentages of persons reporting chilliness and warmth are not far from equal, being 15.3 per cent and 18.5 per cent, respectively.

Reactions of Men and Women Compared

As observed in a previous study,[6] it is found that men prefer a slightly lower indoor temperature than women. According to the comfort curves for the entire period of observation shown in Fig. 10, the greatest proportion of comfort votes from men, 77.8 per cent, is found in the interval 68.6 to 68.9 deg ET. For women, a maximum of 65.0 per cent comfort votes is recorded in the interval 69.8 to 70.1 deg ET. The difference in optimum effective temperature between men and women, in this case 1.2 deg, is presumably related to differences in clothing habits.

There is one further observation to be made under this heading. It will be seen in Fig. 10 that the curve for men falls below that for women at only three points, and then just by small margins. Although it has been stated in the preceding paragraph that men prefer a somewhat lower temperature than women, the present observation suggests that men are not as susceptible as women to discomfort, especially at the extremes of temperatures recorded in this study.

Reactions in Morning and Afternoon Compared

For practically the entire range of temperatures recorded in this study, the clerks expressed a greater degree of comfort in the morning than in the afternoon. This is evidenced in Fig. 11, in which it is seen that the curve for the percentage of clerks expressing comfort (*ideal*) at 11 a.m. lies consistently (with one exception) above the corresponding curve for 3 p.m. It will also be seen that the optimum temperature in the morning is in the interval from 70.6 to 70.9 deg ET, which is one degree higher than the optimum for the afternoon, namely, the interval from 69.8 to 70.1 deg ET.

[6]Loc. Cit. See Note 3.

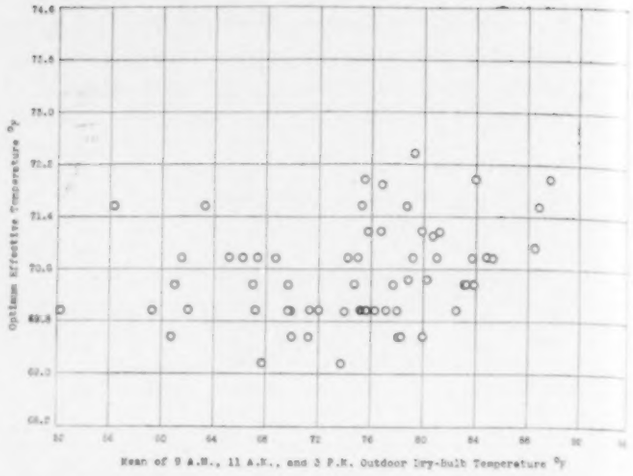


Fig. 6—Relation between daily mean of outdoor dry-bulb temperatures at 9 a. m., 11 a. m., 3 p. m. and optimum effective temperature. July, August and September, 1938

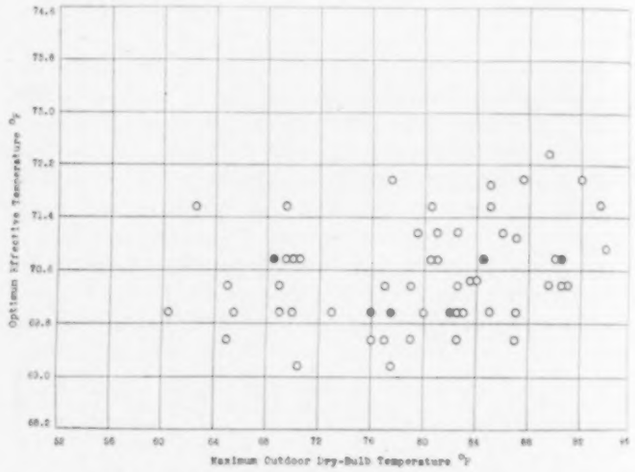


Fig. 7—Relation between daily maximum outdoor dry-bulb temperature and optimum effective temperature July, August and September, 1938

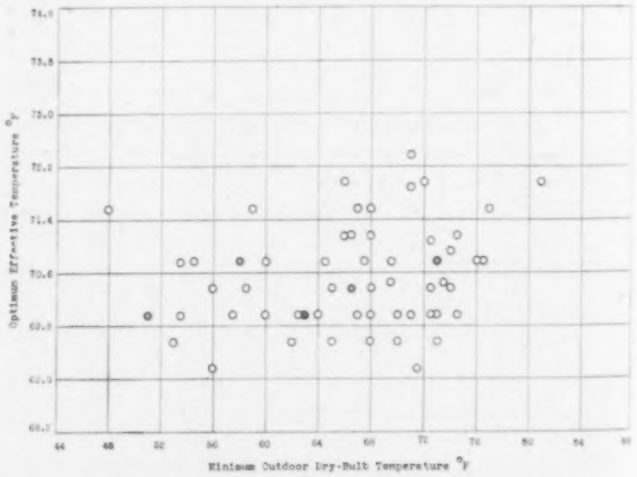


Fig. 8—Relation between daily minimum outdoor dry-bulb temperature and optimum effective temperature July, August and September, 1938

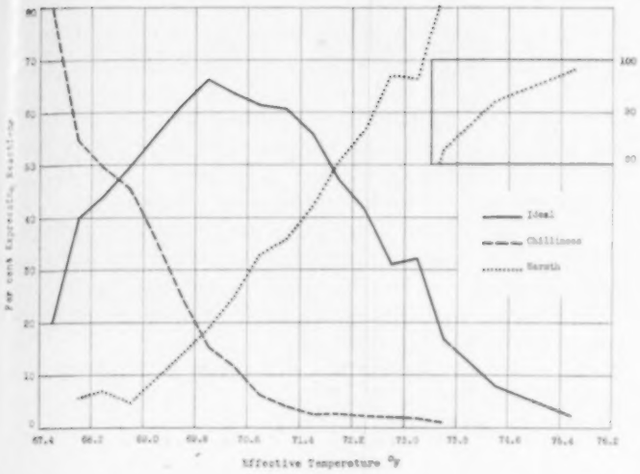


Fig. 9—Relation between effective temperature and percentage of persons indicating comfort, chilliness and warmth. July, August and September, 1938

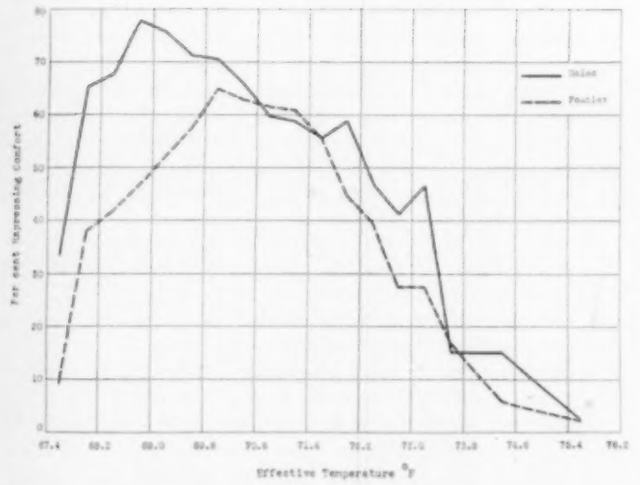


Fig. 10—Relation between effective temperature and percentage of persons indicating comfort for men and women separately. July, August and September, 1938

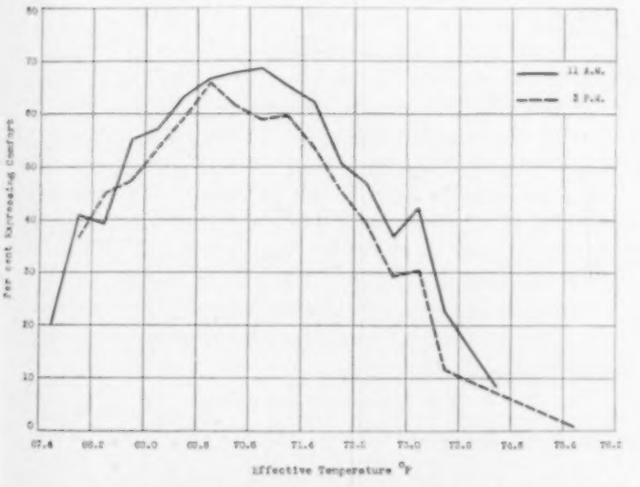


Fig. 11—Relation between effective temperature and percentage of persons indicating comfort at 11 a. m., 3 p. m., both sexes combined. July, August and September, 1938

Study of Fig. 12 shows that the curves of percentages of persons reporting a feeling of chilliness in the morning and in the afternoon are hardly distinguishable. On the other hand, the curve for percentage of persons reporting a feeling of warmth in the afternoon lies almost wholly above the corresponding curve for the morning. Thus, the decrease in the feeling of comfort from the morning to the afternoon is accompanied by an increased feeling of warmth.

Reactions in July, August, and September Compared

The variation in the percent of votes expressing comfort as indoor effective temperature increases is shown separately for July, August, and September in Fig. 13. Within the range from 70 to 71.8 deg ET, the least comfort was registered in July and the greatest comfort in September, with August falling in between. At temperatures below 69.6 deg ET, this situation is reversed, for here it is observed that a greater degree of comfort is found in July than in September. Observations in this low range are not available for the month of August. Above 71.8 deg, there was generally a greater expression of comfort in September than in August. The sharp upturn in the curve for July in this high range is without special significance and may arise from the accidental fluctuations usually ascribed to small numbers of observations.

The optimum temperature for each of three months shows slight variation. In July, it was in the interval from 69.8 to 70.1 deg, with 62.1 per cent of the votes expressing comfort; in August it was in the interval from 69.4 to 69.8 deg (the lowest interval of record for the month), with 70.9 per cent expressing comfort; and in September the optimum interval was again from 69.8 to 70.1 deg with 70.6 per cent expressing comfort.

Within the range of observation, the curve (Fig. 14) for the per cent of votes at various temperatures registering a reaction of *chilliness* in August fell below that of the corresponding curves for July and September. Below 70.0 deg ET, a greater degree of chilliness was registered in September than in July, while above that temperature, this situation is reversed.

Up to 71.2 deg ET, the curves for the percentage of persons expressing a feeling of warmth in July and August are practically identical. At higher temperatures the curve for July becomes erratic, largely because of the chance fluctuation usually associated with small numbers of observations. On the whole, a lesser degree of warmth was expressed in September than in July or August.

The observations in the foregoing paragraphs suggest that the indoor reactions may be related to outdoor temperature conditions.

Comparison with Previous Studies

Laboratory studies in Pittsburgh and Texas pointed to the desirability of a continuous indoor effective temperature of 73 deg as optimum throughout the cooling season. This is somewhat higher than the optimum effective temperature derived from the Ontario study, which was 71 deg. The study made on a group of office workers in Minneapolis indicated that an indoor effective temperature of about 72 deg gave the most satisfactory

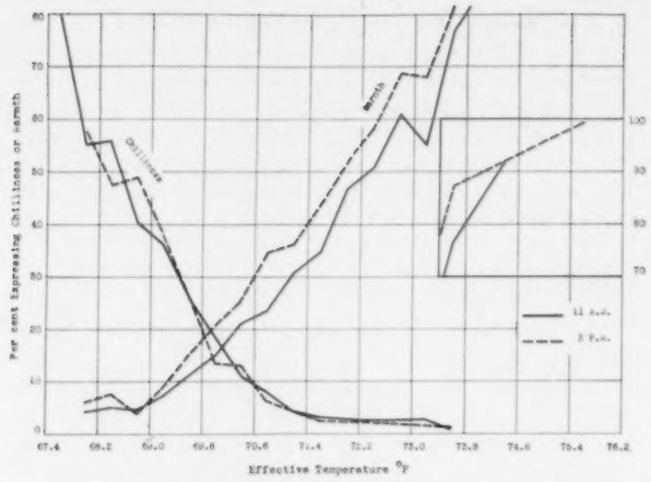


Fig. 12—Relation between effective temperature and percentage of persons indicating chilliness and warmth at 11 a. m. and 3 p. m. July, August and September, 1938

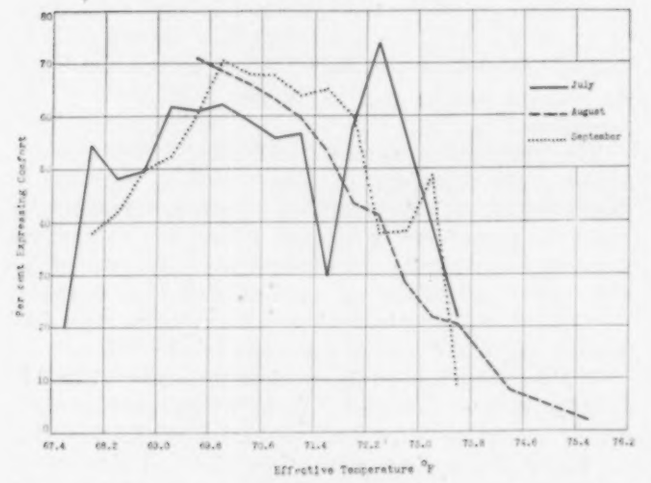


Fig. 13—Relation between effective temperature and percentage of persons expressing comfort during July, August and September, 1938. Both sexes combined

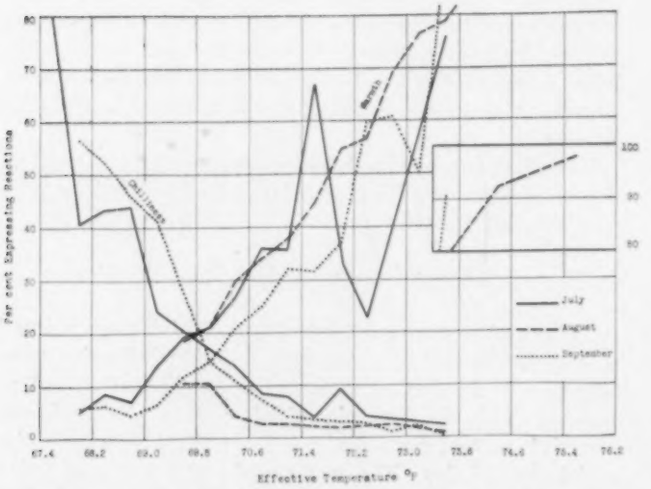


Fig. 14—Relation between effective temperature and percentage of persons indicating chilliness and warmth. July, August and September, 1938

results in the cooling season from July to the middle of September. In the present study, which is based upon 745 clerks in the new unit of the home office of the Metropolitan Life Insurance Co., the optimum effective temperature is found to be about 70 deg during the months of July, August, and September. This is the lowest optimum effective temperature so far noted.

Where differences in optimum temperatures have been noted in this report, as between men and women, morning and afternoon, or between any two of the months of July, August, and September, the results have not been tested for statistical significance. However, where the findings of the present report confirm the findings of previous reports, the conclusions drawn from them gain the weight of added experience.

Summary and Conclusions

1. The present experiment indicates an optimum effective temperature of about 70 deg during the months of July, August and September in the new unit of the home office of the Metropolitan Life Insurance Co.

2. The optimum effective temperature for men was 1.2 deg below that for women. In general, men are not as susceptible as women to discomfort, especially at the extremes of temperatures recorded in this study. Even at the optimum temperatures for women, which differed somewhat from the optimum for men, men still registered a greater percentage of comfort votes than women. Since most of the home office clerks are women, this observation suggests that summer air-conditioning be regulated to the indoor optimum effective temperature for women, namely, 70 deg.

3. In the morning, the optimum effective temperature is about one degree higher than in the afternoon. The decrease in the feeling of comfort from the morning to the afternoon is accompanied by an increased feeling of warmth. This may perhaps be due to the effect of the mid-day meal.

4. The optimum effective temperatures for July, August and September show slight variation from one month to the other.

5. No significant relationship between outdoor temperatures and indoor optimum effective temperature could be found. The conditions of the experiment were not adapted to determine such correlation, since the range of variation of indoor effective temperatures was limited. Although day-to-day changes in outdoor effective temperatures may be looked upon as a guide to day-to-day changes in indoor effective temperatures, the relation between the two is not so close that it can be depended upon for all occasions.

Acknowledgment

The authors acknowledge their gratitude to Dr. A. J. Lotka, Assistant Statistician of the Metropolitan Life Insurance Co., for his guidance in the analysis of the data and for his help in the preparation of this report, to Mr. F. C. Houghten, Director of Research Laboratories, of the American Society of Heating and Ventilating Engineers, for giving the benefit of his wide experience in this field of investigation, and to the Bristol Co., for the loan of temperature recording instruments used in this study.

Coal Conference

The program for the third annual anthracite Conference, to be held May 9 and 10 at Lehigh University, Bethlehem, Pa., has been completed. It calls for 17 papers, many of which concern stokers and related subjects.

Fever Therapy Locally Induced by Conditioned Air

By Murray B. Ferderber, M.D.,* F. C. Houghten,** M.S. (*MEMBERS*), and Carl Gutberlet***
Pittsburgh, Pa.

This paper is the result of research sponsored by the American Society of Heating and Ventilating Engineers in cooperation with the Department of Industrial Hygiene, College of Medicine, University of Pittsburgh

THE empiric use of heat in the treatment of human ailments has extended for countless years. Among the many forms used may be included packs, steam baths, electrical applications such as radiant energy, short-wave, diathermy, etc.[1] Regardless of the method used the ultimate aim is the dilatation of blood vessels to produce increased circulation which in turn causes the affected part to receive the necessary physiological elements for the eradication of pathology.

In the past several years fever therapy (hyperpyrexia, hyperthermia, etc.) has been used extensively for the elevation of body temperature to destroy an invading organism or to increase the elements of resistance within the body itself.[2] A simple fever therapy apparatus was devised[3] where conditioned air was the means of producing the body temperature desirable for the purpose just mentioned.

However, there are many patients whose physical condition or ailments are not indicated for generalized fever therapy and, up to this time, other methods such as radiant energy and diathermy were used. The physiological changes in circulation are seldom produced within a few minutes, because adjustment to conditions is a property of all life that should bear some consideration. When heat is applied there is an eventual dilatation of blood vessels which become engorged, and as a rule, an increase in blood flow is desired.[4] We believe that this increase, to be effective, should occur over a long time rather than during a few minutes. Assuming this practice to be sound, it would follow that any apparatus must be designed so as to deliver helpful and comfortable heat without the dangers of burning or shocking.

Following the line of reasoning used in developing the large fever therapy machine,[5] the Department of Industrial Hygiene, School of Medicine, University of Pittsburgh, with the helpful advice of the ASHVE Research Laboratory, developed an apparatus for inducing elevated temperatures in portions of the human body which has proved successful in every respect. The machine, which may be built to accommodate any portion of the body including an upper and lower extremity, hip, back, or shoulder is shown in Fig. 1 designed to accommodate one or both legs. In this form the device is 43 in. long and 16 in. in diameter and the air conditioning equipment is built in one of the ends of the cylinder while the other end is open to receive the limb. Like the larger fever therapy box this smaller unit contains an air conditioning system of the general dew-point type in which a highly atomized water spray in the upper end of a small duct supplies both the motive power for circulating air and the heat and moisture for saturating it at the desired temperature. Fig. 2 shows a more or less ideal arrangement of the duct system in which the downward passage of the spray gives the air a downward momentum removing it from the lower portion of the box and delivering it saturated at the desired elevated temperature into the top of the chamber. The stratified layer at the top of the box is then drawn downward resulting in little or no temperature gradient throughout a horizontal cross section with a minimum controlled gradient from the top to the bottom.

With a 40-lb water pressure and a 4-in. duct throughout the air conditioning system 9.8 cu ft of air per minute is removed from the bottom of the box, heated and saturated to the desired temperature, and returned to the upper portion. Without insulation 20 to 30 gal of water per hour are sufficient for satisfactory conditions in the box, and if the cylinder is insulated to insure against excessive heat loss to the surrounding atmosphere, a considerably smaller water volume will suffice. A water temperature of 130 F will produce a uniform saturated atmosphere of from 120 to 125 F. Since the air is saturated upon entering the box and loses heat before being returned to the air conditioning part of the cycle, saturation is insured throughout.

Fig. 3 shows a somewhat simpler arrangement, which although lacking the stratifying characteristic in Fig. 2 and insuring a less perfect saturated cycle, gives sufficiently satisfactory performance in such a small apparatus for ordinary purposes. Fig. 4 shows the relation between the pulse before and after treatment, while Fig. 5 shows the change in leucocyte count.

From a comparative standpoint the whirlpool baths using rapidly agitated water from about 108 to 120 F have been used in industrial hospitals to produce a hy-

---

*Research Fellow in Industrial Hygiene, School of Medicine, University of Pittsburgh, and Chairman of the ASHVE Committee on Treatment of Disease.
**Associate Fellow in Industrial Hygiene, School of Medicine, University of Pittsburgh, and Director of ASHVE Research Laboratory.
***Research Assistant, ASHVE Research Laboratory.

[1]Influence and Therapeutic Use of External Heating, by R. Pemberton, C. E. Patten and A. B. Gill. (*Handbook of Physical Therapy*, 2nd Ed.).
[2]Report of the First Year of Fever Therapy Research, Dept. of Industrial Hygiene, School of Medicine, University of Pittsburgh, 1938.
[3]ASHVE Research Report No. 1054—Fever Therapy Induced by Conditioned Air, by F. C. Houghten, M. B. Ferderber and Carl Gutberlet. (ASHVE Transactions, Vol. 43, 1937 p. 131).
[4]Physiological Effects of Heat, by H. C. Basett. (*American Journal of Physiology*, LXXIII: 127, 1933. Handbook of Physical Therapy *AMA*, 2nd Ed.).
[5]Loc. Cit. Note 3.

For presentation at the Semi-Annual Meeting of the American Society of Heating and Ventilating Engineers, Washington, D. C., June 17-19, 1940.

Fig. 1—Patients being treated locally with small fever therapy unit

peremia (increased blood supply). The upper range of temperature in this water bath is apparently too great for comfort and could conceivably cause certain difficulties which might arise in a patient with impaired circulation in the extremities. The ability of a patient to tolerate temperatures between 114 and 120 F, saturated, is outstanding since most of the cases are treated at these temperatures without danger of complications. From experience it has been found that it is necessary to treat a patient 1 to 3 hours to produce desired effects, and the index of improvement increases with each succeeding treatment. Usually a course of treatments would consist of 36 hours at a pre-determined temperature usually divided into 12 treatments of 3 hours each given daily or every other day. At this writing the only contra-indications to this form of therapy have been sloughing of a part including gangrene, very severe circulatory deficiency in the extremity, and trophic ulcers which are due to certain diseases of the nervous system. The increase in pulse rate is fairly insignificant, and the rise in leucocyte count would average about 1500 cells, which may be purely a personal variation in making the counts. The rise in body temperature resulting from this treatment is insignificant and varies from no rise to a maximum rise of from 1 to 1½ F. This increase did not affect even those patients suffering from severe cardiac lesions.

Most of the patients enjoy the treatment because the apparatus is placed on a comfortable hospital bed, and frequently the individual falls fast asleep without the addition of a sedative. The observations indicate that men tolerate temperatures as high as 125 F, while women are more comfortable between 115 and 118 F. In attempting to evaluate its clinical value the cooperation of a prominent industrial surgeon was fortunately obtained, whose wide experience would add much to the experimental knowledge.[6] The first patients treated were those who had sustained fractures following which stiffness of surrounding joints and tendons resulted in disability. Most of these individuals were treated with other physical methods, but there was little or no improvement. To the satisfaction of all workers improvement was noticeable following the inception of saturated heat treatments. In some few cases where the stiffness persisted, gentle manipulations were performed by the surgeon followed by these heat treatments, and improvement became more evident. Very often following open reduction of fractures, or from other causes, edema (swelling) of an extremity may occur, characterized by considerable enlargement of the leg or arm and a shiny, stretched skin. Local fever therapy was especially efficacious in this type of disability, and both lymphatic and blood circulations were vastly improved as evidenced by the reduction and swelling previously mentioned.

The so-called simple sprain produces rather extensive disability and *time off* whether it be industrial or domestic. Early intensive treatment is indicated, and almost immediate relief from this particular type of accident has been obtained.

In the course of the investigations many patients with varicose ulcers were treated routinely in order to determine the uses for which this modality might be indicated. The satisfactory results were not only surprising but gratifying, and it has since become a routine treatment in one of the hospitals cooperating with the Fever Therapy Research Fund of the Department of Industrial Hygiene, University of Pittsburgh.

Peripheral vascular diseases result from impaired circulation of the extremities, and it is axiomatic in medicine that a suitable form of heat is necessary to aid in the relief of pain and the restoration of collateral circulation. While experimental evidence would indicate the value of moist heat, additional work is necessary to definitely establish the range of temperatures and the time allotted for treatment. It is known, however, that lower dry-bulb temperatures are necessary in some cases, and good clinical judgment should dictate that this form of treatment must not produce pain in these patients.

[6]Local Application of Fever Therapy, by M. B. Ferderber, J. Huber Wagner, A. Sherrill and Samuel Sherman. (Preliminary Report, *Departmental Publication*).

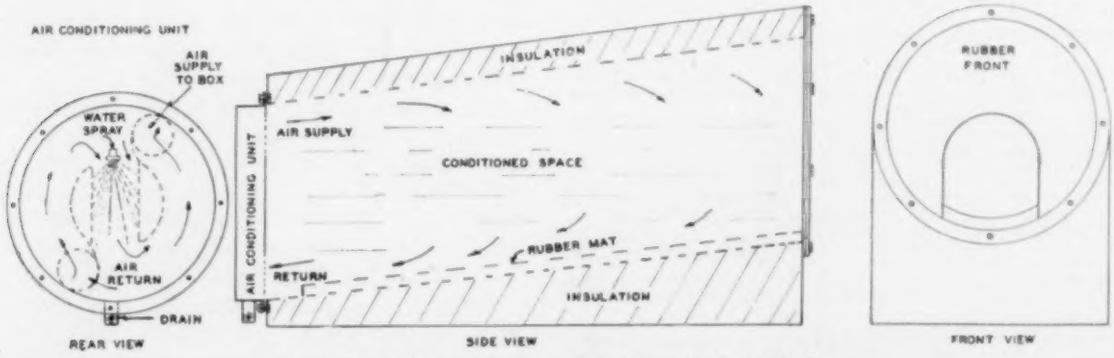


Fig. 2—Local fever therapy box with stratified circulation

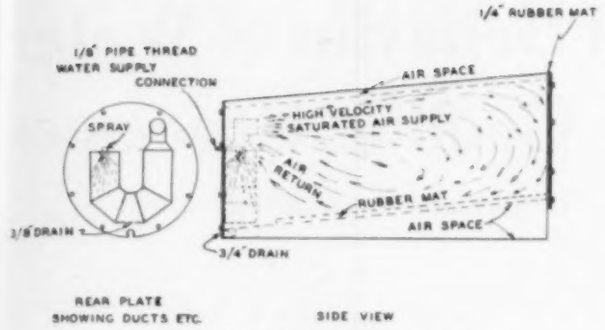


Fig. 3—Local fever therapy box

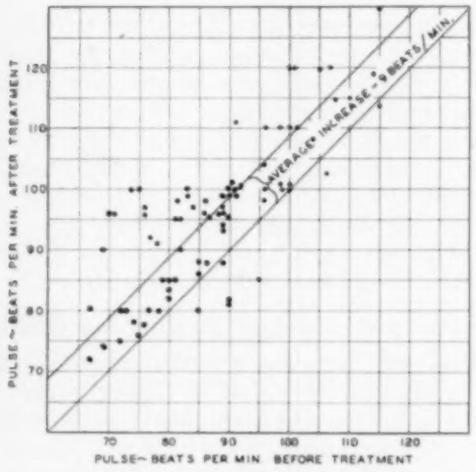


Fig. 4—Relation between the pulse before and after treatment

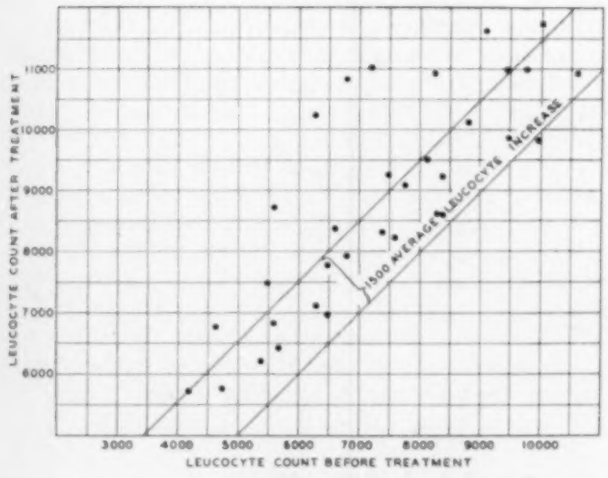


Fig. 5—Change in leucocyte count before and after treatment

Animal experiments carried on in the laboratories of the Fever Therapy Research Fund definitely show that the rate of blood flow is considerably greater when moist heat is used, and the deep muscle temperatures produced show a maximum of 107 F, which is definitely in the safe physiologic range. However, another method for inducing local heat causes a deep temperature of approximately 109 F, and there is the possibility that this temperature may be either above or near the upper limit of physiological tolerance. Another very interesting observation was the retention of the deep muscle heat which lasted considerably longer when produced by saturated heat. The value here lies in the fact that the patient receives the advantage of continued dilation and increased blood supply which are the basic causes for the deep temperature.

The treatment of arthritis has been subject to much controversy for many years and aside from those cases resulting from specific infection, there have been as many forms of treatment as there are physicians recommending it. We do not offer this form of treatment as a remedy for this disease, but where there is localization of pain in the joints of an extremity, relief has been given so that following the original course of treatments, patients remain symptom-free for some time and occasionally return for treatment to avoid complete return of pain and disability.

Acknowledgments

The authors acknowledge the valuable cooperation offered by Dr. W. S. McEllroy, Dean, and Dr. T. Lyle Hazlett, Director of the Department of Industrial Hygiene, School of Medicine, University of Pittsburgh, for making this study possible. The authors wish to thank also the administrators and staff members of the cooperating hospitals for their assistance in evaluating the clinical research carried on with the local heating devices. Without their aid this study could not have been carried on.

Refrigerating Engineers at Skytop

The 27th Spring Meeting of the *American Society of Refrigerating Engineers,* will be held at Skytop Club, Skytop, Pa., June 9, 10, 11. L. L. Lewis, Carrier Corp., has arranged the technical program, which will feature the newest developments and practical information in commercial and industrial refrigeration, and one session devoted to air conditioning will consider air distribution problems and sales methods. Morning sessions will be held so that afternoons will be left free for golf on the famous Skytop courses.

Entertainment will be started with an informal party at Skytop Club on Sunday evening, June 9, when a colored movie entitled "The Lore of the Poconos" will be one of the features. The usual *ASRE* golf tournament will be played on Sunday, Monday and Tuesday afternoons, and the Society's summer dinner-dance will be held Monday evening. R. E. Townsend, Detroit Lubricator Co., is chairman of the entertainment committee and C. R. Logan, Superior Valve & Fittings Co., an old hand at *ASRE* social events, will assist him.

Corrosion in Air Conditioning

Corrosion of metals exposed to conditioned air or spray water used for cooling and dehumidifying is a problem now actively being studied by the Research Technical Advisory Committee on Corrosion. A report of progress showing the relative resistance of several alloys to corrosion when hung in an air stream or when submerged in an inhibited spray water is being prepared by the Committee of which A. R. Mumford, New York, N. Y., is chairman.

In addition, tests are being arranged to study the protective power of several recently developed resistant coatings. These coated specimens will be exposed both to the air and by submergence in the spray water of the same system that was used for the uncoated metals. Also duplicates will be similarly exposed to a system which has had the greatest difficulty from attack on metal that is available and accessible to the Committee.

Dynamic and Thermal Behavior of Water Drops in Evaporative Cooling Processes

By H. B. Nottage,* Chicago, Ill., and L. M. K. Boelter** (*MEMBER*), Berkeley, Calif.

This Report (Part 2) is the result of cooperative research sponsored by the Committee on Research of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS and conducted at the University of California, Berkeley, California

Drop Dynamics

THE dynamic behavior of a water drop as it rises or falls in still or moving air is the introductory phase of the study of the energy transfer phenomenon from sprays to the surrounding gas. The results of preliminary calculations were included in Part 1 of this report.[1]

Falling Drops, Initially at Zero Velocity, in Still Air

Briefly, the equation of motion

$$mg - C\frac{A\rho v^2}{2} = m\frac{dv}{d\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1a)$$

is rearranged in a form convenient for graphical integration as follows:

$$\int_0^\theta d\theta = \int_0^v \frac{dv}{g - C\frac{A\rho v^2}{2m}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2a)$$

and

$$\int_0^s dS = \int_0^\theta v\, d\theta \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2b)$$

for a drop falling from rest into still air. The resistance coefficient has been obtained from several sources[2,3,4,5,6,7] and is represented in Fig. 1 for spheres, water drops, methyl salicylate drops (surface tension approximately one-half that of water), and flat plates. Steady-state Reynolds' moduli which describe the maximum velocity with which drops of various sizes fall through still air, and the limiting Reynolds' moduli corresponding to the maximum velocities for which various drop sizes are stable, are also presented in the same figure. The limiting Reynolds' moduli are nearly independent of equivalent drop diameter indicating that the limiting velocities vary approximately inversely as the equivalent diameters. The data of Flower were eventually thought to be the least reliable of those available and were not used in later computations.

The results of the graphical integrations for the fall of drops from rest in still air are revealed in Figs. 2 and 3 for equivalent drop diameters equal to 0.2, 0.5, 1.0, 2.0, 3.0, 4.0 and 6.0 mm. The resistance data of Flower (*F*) and Liznar (*L*) were used to establish the drag coefficient (*C*). The steady-state velocity curve is almost a linear function of equivalent drop diameter for drops below 1.0 mm in diameter. The maximum steady-state velocity appears to correspond to a drop diameter of approximately 6 mm. Curves *B* and *D* of Fig. 1 indicate that the steady-state velocity and the limiting velocity coincide for a drop diameter of 8 mm; this magnitude defines the maximum stable drop.

Falling Drops, Ejected from Nozzles, Into Still Air

Drops ejected vertically downward from nozzles into stationary air and moving at the limiting velocity, the greatest velocity for which the drop is stable, will decelerate to the steady-state velocity under the action of the air resistance. The graphical integration is accomplished by the aid of Equations 2 *a* and *b*, the lower limit of integration being the limiting velocity. The space-velocity-time results for drop sizes from 0.2 to 6.0 mm equivalent diameters are graphed in Figs. 4, 5 and 6. Interpolation between tabular values† will yield results of satisfactory accuracy for those magnitudes of distance not included on the curves. The curves are nearly straight in these regions.

For smaller drops the predominating force is the air resistance and the steep curve slopes reveal high rates of deceleration. The smaller rate of deceleration of large drops is due to a greater mass and the fact that the limiting velocity and the steady-state velocity are not greatly different in magnitude.

These results are not applicable directly to cases in which descending drops are coalesced or shattered upon collision but apply only to individual drops.

Drops Projected Upward in Still Air

The equation of motion becomes:

$$mg + C\frac{A\rho v^2}{2} = m\frac{dv}{d\theta} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1b)$$

because the force of gravity and the air resistance both act to decelerate the drop. The limits of integration are the limiting velocity and zero velocity, the latter corresponding to the maximum rise of the drop. Resistance coefficients according to Liznar were used for these computations. The results of the computations are revealed in Figs. 7, 8 and 9.

The maximum distance of rise, approximately 16 ft,

*Instructor, Mech. Engrg., Armour Institute of Technology, Chicago, Ill.
**Professor, Mech. Engrg., University of California, Berkeley, Calif.

[1] Boelter, L. M. K., Cooling Tower Performance Studies. (ASHVE JOURNAL SECTION, *Heating, Piping and Air Conditioning*, October, 1939).
[2] Liznar, J., *Meteorol. Zeitschr.*, 31, 339 (1914).
[3] Schmidt, W., *Aka. Wiss. Wien Sitzungsber.*, 118:2a, 71 (1909).
[4] Lenard, P., *Meteorol. Zeitschr.*, 21, 249 (1904).
[5] Lenard, P., *Ann. Physik*, IV-65, 629 (1921).
[6] Flower, W. D., *Proc. Phys. Soc. London*, 40, 167 (1928).
[7] Wieselsberger, C., *Zeitschr. Flugtech. Motorluftschiffahrt*, 5, 140 (1914).

Presented at the 46th Annual Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Cleveland, Ohio, January, 1940.

†Complete tables will appear in the ASHVE TRANSACTIONS.

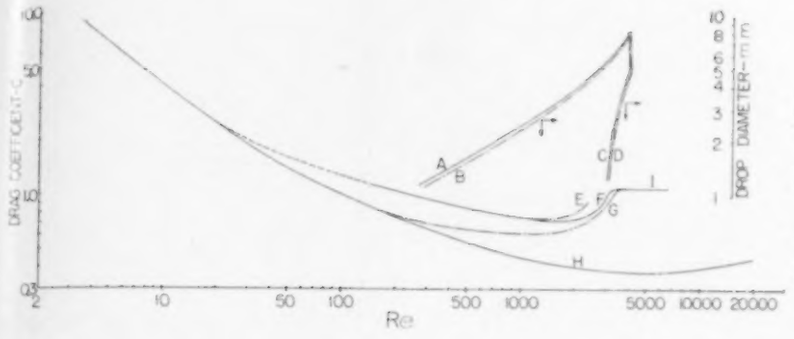


Fig. 1—Drop dynamics

STEADY STATE REYNOLDS' NUMBER PLOTTED AS A FUNCTION OF DROP DIAMETER

A Flower and Wieselsberger
B Liznar and Wieselsberger

LIMITING REYNOLDS' NUMBER FOR STABLE DROP AS A FUNCTION OF DROP SIZE

C Lenard and Flower
D Lenard and Liznar

DRAG COEFFICIENT AS A FUNCTION OF REYNOLDS' NUMBER

E	Methyl salicylate drop	—Flower
F	Water drops	—Flower
G	Water drops	—Liznar
H	Spheres	—Wieselsberger
I	Flat plates	—Wieselsberger

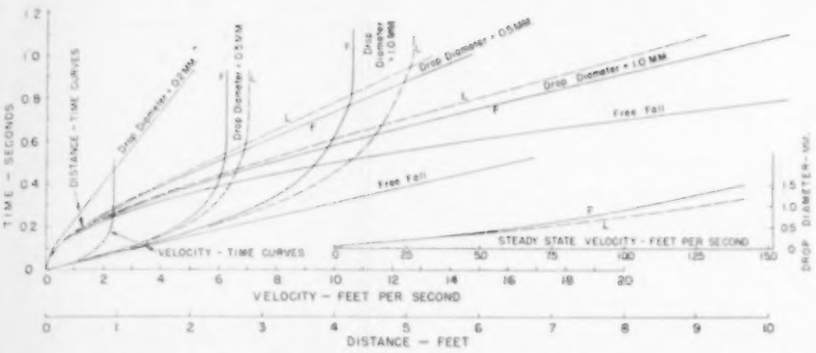

TIME - SECONDS
DISTANCE - TIME CURVES
Drop Diameter - 0.5MM
Drop Diameter - 1.0 MM
Free Fall
VELOCITY - TIME CURVES
VELOCITY - FEET PER SECOND
DISTANCE - FEET
STEADY STATE VELOCITY - FEET PER SECOND
DROP DIAMETER - MM

Fig. 2—A. Space-velocity-time curves for water drops falling from rest through still air
B. Steady state velocity-equivalent diameter curves

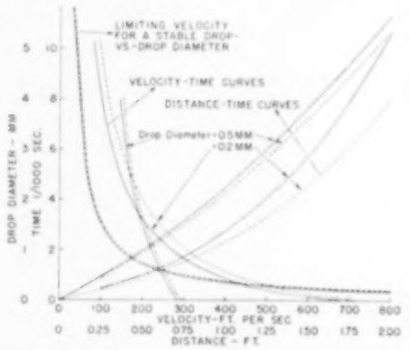


Fig. 4—A. Space-velocity-time curves for drops projected downward at the limiting velocity into still air and decelerated to the steady state velocity. (Time range: $0 < \theta < 0.01$ sec.)
B. Limiting velocity of a stable drop as a function of equivalent drop diameter

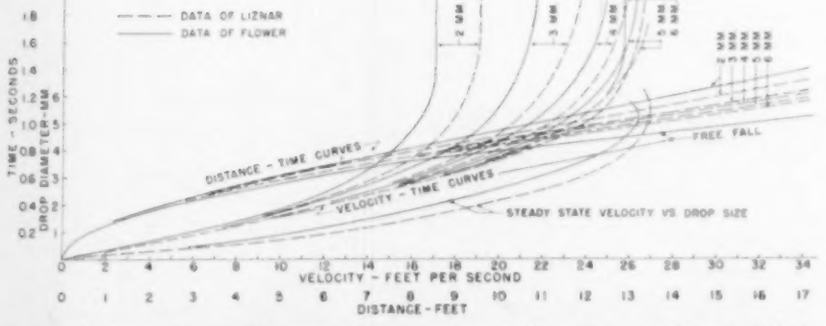


Fig. 3—A. Space-velocity-time curves for water drops falling from rest through still air
B. Steady state velocity-equivalent diameter curves

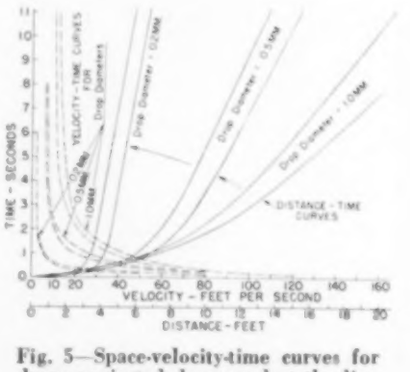

VELOCITY-TIME CURVES FOR Drop Diameters
Drop Diameter - 0.2MM
Drop Diameter - 0.5MM
Drop Diameter - 1.0MM
DISTANCE - TIME CURVES
TIME - SECONDS
VELOCITY - FEET PER SECOND
DISTANCE - FEET

Fig. 5—Space-velocity-time curves for drops projected downward at the limiting velocity into still air and decelerated to the steady-state velocity. (Time range: $0 < \theta < 1.0$ sec.)

corresponds to drops of 2 to 3 mm diameter. In this size range the air resistance is least effective in opposing the inertia force during deceleration from the limiting velocity. The maximum height noted for each drop size refers to the trajectory of a single drop. A greater height would be attained by a stream of many drops discharged upward together because the flow system about any single drop is changed by drop interference, collision, and the jet action of the air set into motion by the liquid stream. A decrease in both the relative velocity with respect to the air and the magnitude of the resistance coefficient would result. For the case of jets discharging upward, the height of the undispersed jet should be added to the computed height for each drop size to obtain the actual rise above the level of the nozzle.

Drops Falling from Rest Through Air Moving Upward at Various Velocities

The motion of a drop with respect to moving air presents an extremely important problem. The solution of one phase of this problem for drops falling through vertically upward moving air is made possible by the application of the principle of relative motion to the curves of Figs. 2 and 3.

For the system under consideration

$$\left.\begin{aligned} V_{\text{drop}\rightarrow\text{air}} &= V_{\text{drop}} + V_{\text{air}} \\ \int_0^{\theta} V_{\text{drop}}\, d\theta &= \int_0^{J} \left(V_{\text{drop}\rightarrow\text{air}} - V_{\text{air}}\right)^{d\theta} \\ S_{\text{drop}} &= S_{\text{Fig. 2 and 3}} - V_{\text{air}}\,\theta \end{aligned}\right\} \quad \ldots\ldots\ldots (3)$$

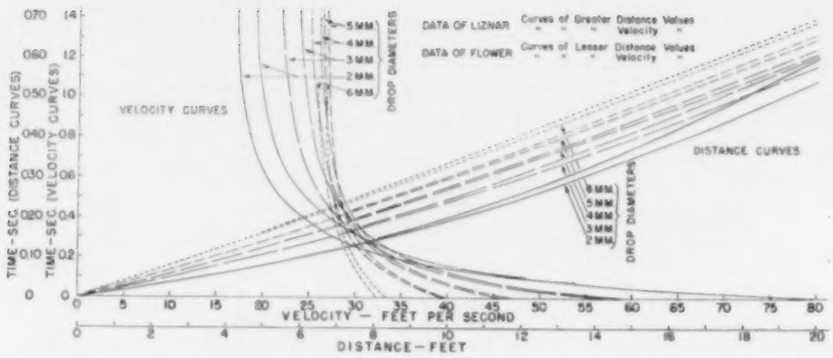


Fig. 6—Space-velocity-time curves for drops projected downward at the limiting velocity into still air and decelerated to the steady-state velocity. (Time range $0 < \theta < 1.00$ sec.)

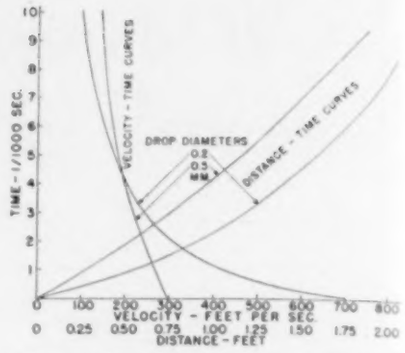


Fig. 7—Space-velocity-time curves for drops projected upward at the limiting velocity into still air. Resistance coefficients from Liznar. (Time: $0 < \theta < 0.010$ sec.)

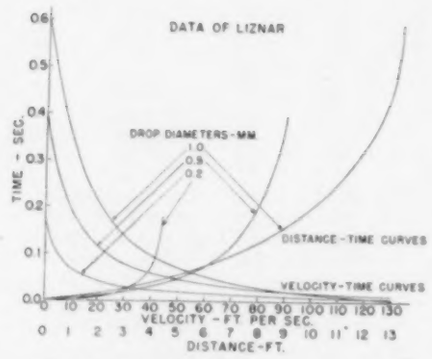


Fig. 8—Space-velocity-time curves for drops projected upward at the limiting velocity into still air. (Time: $0 < \theta < 0.6$ sec.)

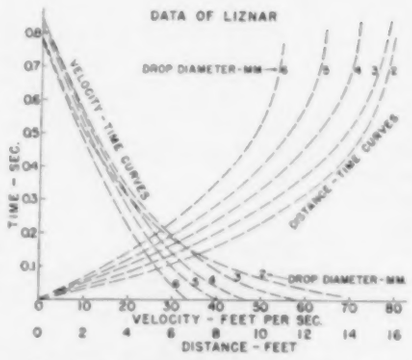


Fig. 9—Space-velocity-time curves for drops projected upward at the limiting velocity into still air. (Time: $0 < \theta < 0.6$ sec.)

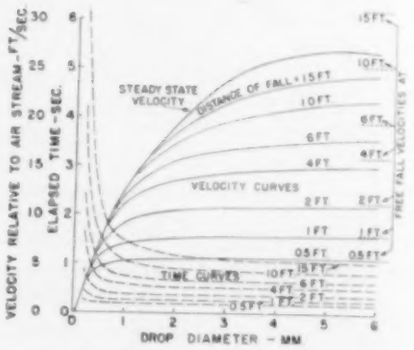


Fig. 10—Drop velocity relative to air and elapsed time as a function of drop diameter for various distances of fall from rest into still air. (Resistance data from Liznar)

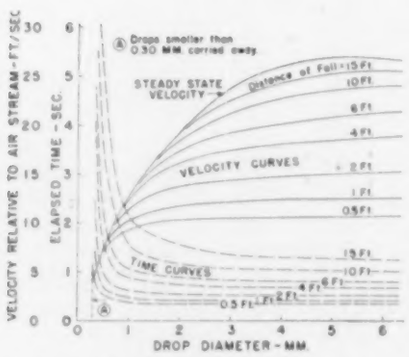

Drops smaller than 0.30 MM. carried away.
STEADY STATE VELOCITY
VELOCITY CURVES
TIME CURVES
VELOCITY RELATIVE TO AIR STREAM - FT./SEC.
ELAPSED TIME - SEC.
DROP DIAMETER - MM.

Fig. 11—Drop velocity relative to air and elapsed time as a function of drop diameter for various distances of fall from rest into air moving upward at 2 fps

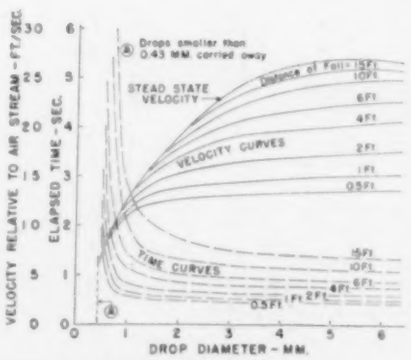

Drops smaller than 0.43 MM. carried away.
STEADY STATE VELOCITY
VELOCITY CURVES
TIME CURVES
VELOCITY RELATIVE TO AIR STREAM - FT./SEC.
ELAPSED TIME - SEC.
DROP DIAMETER - MM.

Fig. 12—Drop velocity relative to air and elapsed time as a function of drop diameter for various distances of fall from rest into air moving upward at 4 fps

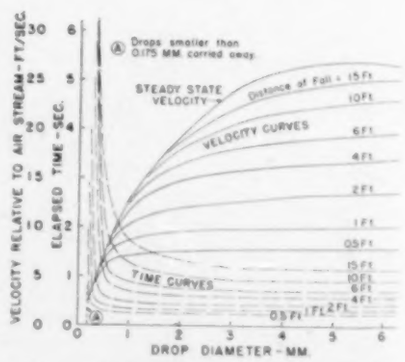

Drops smaller than 0.175 MM. carried away.
STEADY STATE VELOCITY
VELOCITY CURVES
TIME CURVES
VELOCITY RELATIVE TO AIR STREAM - FT./SEC.
ELAPSED TIME - SEC.
DROP DIAMETER - MM.

Fig. 13—Drop velocity relative to air and elapsed time as a function of drop diameter for various distances of fall from rest into air moving upward at 6 fps

The velocities plotted in Figs. 2 and 3 are those of the drop relative to that of the air ($V_{drop \rightarrow air}$) through which it is traveling. $S_{Fig.\ 2\ and\ 3}$ is a function of time (θ) and, when known, $V_{drop \rightarrow air}$ is fixed.

For a given displacement of the drop in space a graphical solution of Equations (3) may be employed. A straight edge is placed on the curve sheet with a slope $1/V_{air}$ and intersecting the point ($S = S_{drop}$, $\theta = O$). Intersection of the line thus defined with the distance-time curve yields the time necessary to traverse the distance through the moving air stream. The corresponding relative velocity of the drop ($V_{drop \rightarrow air}$) is read from the velocity-time curve and the absolute velocity of the drop (V_{drop}) is computed from the first of Equations (3). The resistance data of Liznar were used for these computations.

The results for distances of fall from 0.5 to 15 ft and air stream velocities upward of 2, 4, 6 and 10 fps are plotted in Figs. 10 to 14. The high relative velocity between the drop and the air stream increases the rates of heat and mass transfer, but the loss of small drops (called drift) offsets advantages realized beyond a cer-

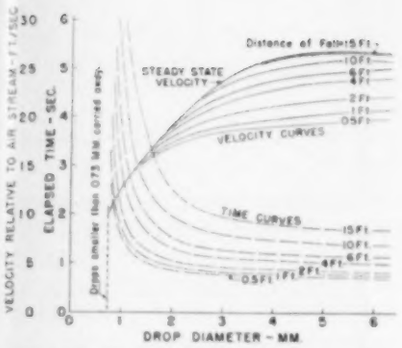

VELOCITY RELATIVE TO AIR STREAM - FT./SEC.
ELAPSED TIME - SEC.
DROP DIAMETER - MM.
Distance of Fall=15 Ft.
STEADY STATE VELOCITY
VELOCITY CURVES
TIME CURVES
Drops smaller than 0.73 MM carried away

Fig. 14—Drop velocity relative to air and elapsed time as a function of drop diameter for various distances of fall from rest into air moving upward at 10 fps

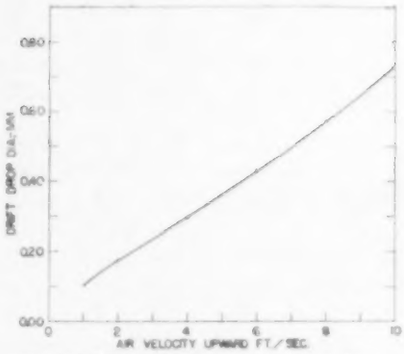


Fig. 15—The upper limit of drop sizes which constitute drift in a contraflow tower as a function of upward air velocity

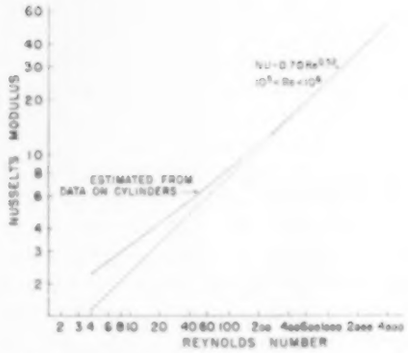


Fig. 16—Heat transfer function for spheres in currents of air

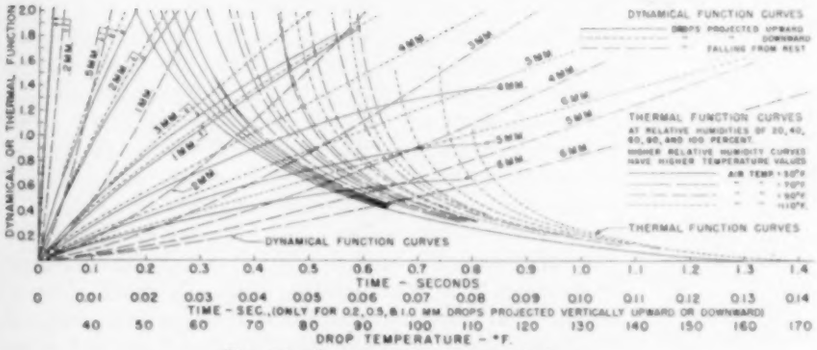

DYNAMICAL OR THERMAL FUNCTION
DYNAMICAL FUNCTION CURVES
THERMAL FUNCTION CURVES
TIME - SECONDS
TIME - SEC. (ONLY FOR 0.2, 0.5, & 1.0 MM DROPS PROJECTED VERTICALLY UPWARD OR DOWNWARD)
DROP TEMPERATURE - °F.

Fig. 17—Evaporative cooling of drops

Dynamical function $f\psi d\theta$
Thermal function $f\phi dt$
Drops falling from rest in still air
Drops falling in still air from the limiting velocity to the steady-state velocity
Drops projected vertically upward in still air at the limiting velocity and decelerating to zero velocity
Drop diameters: 0.2, 0.5, 1.0, 2.0, 3.0, 4.0, 5.0 and 6.0 mm
Dry-bulb temperatures: 50, 70, 90, 110 F
Relative humidities: 20, 40, 60, 80, 100 per cent
Initial drop temperature = 170 F

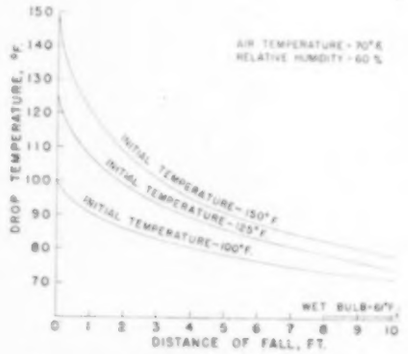

DROP TEMPERATURE, °F.
AIR TEMPERATURE - 70° F.
RELATIVE HUMIDITY - 60 %
INITIAL TEMPERATURE - 150° F.
INITIAL TEMPERATURE - 125° F.
INITIAL TEMPERATURE - 100° F.
WET BULB - 61° F.
DISTANCE OF FALL, FT.

Fig. 18—Evaporative cooling of a 5 mm water drop falling from rest through still air (Air temperature = 70 F R. H. = 60 per cent W. B. = 61 F)

tain optimum condition which obtains for each particular instance. Fig. 15 reveals the diameters of drops, all sizes below which may constitute drift in a contraflow tower. The relative velocity affects the rate of heat and mass transfer, but the absolute velocity is the determining factor in fixing the size of the equipment and in the impact process when a drop strikes wetted solid surfaces.

Computations of the Evaporative Cooling of Water Drops in Air

The decrease in temperature of a drop moving with respect to air may be computed by integrating equations which express an energy balance and a mass balance. The idealized water-air system may be described as follows:

1. Distance-velocity-time data included in this paper describe the behavior of the drops.
2. The relation between unit mass conductance and unit thermal conductance as determined from psychrometric data is valid.
3. The transient problem may be analyzed as a succession of steady-state conditions.
4. During the period of acceleration (positive and negative) the drops are spheres of infinite thermal conductivity.
5. Unit thermal conductances in the range available for spheres[8] also apply to the water drops,

$$Nu = 0.70\ Re^{0.52},\ 10^3 < Re < 10^5 \quad \ldots\ldots(4)$$

6. Unit thermal conductances for spheres in the range not available from the literature are obtained by the application of the proportion:

$$\frac{(Nu_{\mathrm{Re}<10^5})\text{spheres}}{(Nu_{\mathrm{Re}<10^5})\text{cylinders}} = \frac{0.70\ Re^{0.52}}{0.35\ Re^{0.58}}, \quad \ldots\ldots(5)$$

where[9]: $Nu = 0.35\ Re^{0.58},\ 10^3 < Re < 10^5, \quad \ldots\ldots(6)$

represents the thermal behavior of cylinders in cross flow. The data for cylinders at small Reynolds' moduli are obtained from McAdams.[10] The magnitudes employed in the computation are revealed in Fig. 16.

7. The equivalent radius (R_e) of the drop is constant during the evaporation process. In cooling tower work the radius decreases in magnitude, but not over 5 per cent.
8. Drop diameters are not changed by collision.

The application of an energy balance and a mass balance (in time interval $d\theta$) to the ideal system described leads to the following equation:

$$\frac{3}{2}(Nu)\,d(Fo)\left(1+\frac{f_r}{f_c}\right)=\frac{\dfrac{dt}{t-t_s}}{\left(\dfrac{k_s}{k_1}\right)\left[1+\dfrac{U'r}{R_r T_m f_c\left(1+\dfrac{f_r}{f_c}\right)}\left(\dfrac{P_w-P_s}{t-t_s}\right)\right]} \quad \ldots\ldots(7)$$

Except for the term $\left(1+\dfrac{f_r}{f_c}\right)$, the left side of Equa-

[8]Büttner, K., *Veröffentlichungen des Preussischen Meteorologischen Institutes, Abhandlung*, 10, No. 3 (1934).

[9]Reiher, H., *V.d.I. Forschungsarbeiten*, No. 322 (1929).

[10]McAdams, W. H., Heat Transmission, p. 219, McGraw-Hill Book Co., New York, 1933.

tion (7) depends upon dynamical conditions only (since Nu is a function of Re, see Fig. 16) and the right side depends only upon thermal conditions for a given magnitude of the partial pressure of the water vapor far away.

Dynamical Function

$$\text{To evaluate } \frac{3}{2} \cdot Nu \cdot d(Fo) \cdot \left(1+\frac{f_c}{f_c}\right) = \psi d\theta \ldots\ldots (8)$$

the following procedure is utilized: reference to the velocity-time curve yields Re, then Nu is obtained from Fig. 16, and the magnitude of f_c computed from $Nu = 2\ R_o\ f_c/k_a$. The unit thermal conductance for radiation (f_r) is chosen as 1.05 Btu per hour per square foot per degree Fahrenheit and is treated as a constant for the system under consideration. The area under the plot ψ vs. θ yields the integral $\int \psi d\theta$, where

$$\psi = \frac{3}{2}(Nu)\left(\frac{\bar{u}}{R_o^2}\right)\left[1+\frac{1.05}{(Nu)\ k_a/2R_o}\right] \ldots\ldots (9)$$

The magnitudes of these integrals are shown in Fig. 17 as a function of time (θ) for various drop diameters, the drops falling through still air from rest, falling in still air from the limiting to the steady-state velocities, and rising in still air from the limiting to zero velocities. The data of Liznar were used to establish the kinetic behavior of the drop. Steady-state magnitudes of $\int \psi d\theta$ may be obtained by direct integration (Nu and f_c are constant). Values of ψ for zero velocity were estimated from data by King,[11] employing an average magnitude of the free convection modulus times the fluid property modulus (Gr·Pr) for each drop. All properties in these moduli are evaluated for the air-water vapor mixture at conditions corresponding to the arithmetic mean of the temperature of the drop (gaseous side of the liquid-gas interface) and the air-water vapor mixture far away and at the corresponding mean humidities.

Thermal Function

The evaluation of the integral of the right side of Equation (7) for the range of dry-bulb temperatures and relative humidities usually encountered in cooling towers subject to the definition of the ideal system may be also accomplished graphically. The ratio of air-water vapor thermal conductivity to water thermal conductivity is relatively invariable in the temperature range under consideration and has been set equal to 0.420. The Keenan and Keyes Steam Tables (1938) were used as a source for vapor pressure and heat of vaporization data. Results of psychrometric experiments establish (f_c/U') as 0.01635 Btu per cubic foot per degree Fahrenheit. Except for the factor $(1 + f_r/f_c)$, the right side of Equation (7), namely,

$$\frac{1}{\left(\frac{k_a}{k_1}\right)\left[(t-t_a)+\frac{r(P_w-P_g)}{R_v T_m (f_c/U')(1+f_r/f_c)}\right]} dt = \Phi dt \ldots\ldots (10)$$

depends only on the thermal conditions of the drop for a given partial pressure of the water vapor far away. In order to separate the dynamical and thermal effects, the factor $(1 + f_r/f_c)$ is here set equal to 1.03 as a working approximation. An initial drop temperature of 170 F was chosen as representative of the maximum temperature at which water is delivered to the system, but the curves are applicable to any initial temperature below this magnitude. The integral $\int_{170}^{t} \Phi dt$ is revealed graphically in Fig. 17.

[11] King, W. J., *Mechanical Engineering*, 54, 347 (1932).

Application of the ψ and Φ Functions to the Solution of the Drop Cooling Problem.

1. *A generalized comparative representation of the temperature-time relations:* The temperature-time history of a water drop under any combination of dynamical and thermal conditions within the range studied may be obtained from Fig. 17. The dynamical and thermal functions, $\int \psi d\theta$ *and* $\int \Phi dt$ respectively, are plotted as ordinates to the same scale. Elapsed time serves as the abscissa for the dynamical curves, and drop temperature serves likewise for the thermal curves. In accord with the solution indicated by Equation (7), the drop temperature is found as a function of elapsed time for a given vertical trajectory and drop size in the following manner: For a given interval of time, the increment in the dynamical function is indicated directly by the curve corresponding to the drop diameter and trajectory under consideration. Then, for a given initial drop temperature and air state, the final drop temperature corresponding to the given change in the dynamical function is obtained by increasing the ordinate (the initial point on the thermal function curve is fixed by the initial drop temperature) of the particular thermal function curve which corresponds to the air state far away by the amount of the specified dynamical function increment and reading the drop temperature as the abscissa of the point so determined.

The lower cooling limit of the thermal function curves is that drop temperature for which the quantity ψ is infinite, i.e., the temperature which prevails independent of time when a balance has been established between the rates of heat loss and gain by the drop. Actual equipments are seldom, if ever, designed to attain this temperature because of the relative ineffectiveness of the cooling process in the region of close approach and the consequent large size of transfer chamber required. The lower limiting temperature is closely defined by the wet-bulb temperature of the air-vapor mixture involved, magnitudes of which as obtained from a psychrometric chart are given in Table 1.

Table 1—Lower Limiting Temperatures for Air-Vapor Mixtures

Dry Bulb, F	Wet-Bulb Temperatures, R. H. Per Cent				
	20	40	60	80	100
50	36.8	40.5	43.9	46.9	50
70	50.1	55.9	61.0	65.8	70
90	66.0	71.2	78.3	84.5	90
110	75.4	86.6	95.6	103.5	110

The scale used in Fig. 17 causes extrapolation of the cooling curves to the limiting temperatures to be impractical in some cases, so that if it becomes necessary to work within the region of 2 or 3 deg approach a linear extrapolation will serve as an adequate approximation.

By using time as the independent variable for the dynamical curves, the analysis may be applied to motion through an air stream travelling at any known velocity relative to the drop. The dynamical function is a definite integral evaluated in terms of the relative velocity. Therefore, if a certain relative velocity exists at the

instant that the drop starts its trajectory, net increments of the dynamical function are to be reckoned above the value corresponding to an equivalent time of travel required for the drop to attain a velocity equal to that of the air stream while passing through still air. A similar procedure applies to the case of drops decelerated from a velocity smaller than the limiting velocity. The previously determined velocity-distance-time data and curves present the necessary information for the execution of such calculations.

For the case in which drops are descending or ascending through air the temperature and humidity of which are a space function, the ordinate increment obtained from the dynamical function is added to the initial ordinate (located on the curve defined by the initial air temperature and relative humidity parameter) corresponding to the initial drop temperature. The intersection of the ordinate increment with the thermal function curve defined by the air temperature and relative humidity at the new position of the drop in the system (i.e., $S + \triangle S$ corresponding to $\theta + \triangle\theta$) yields the drop temperature in the new environment.

The comparative shape and location of the curves in Fig. 17 serve to indicate performance trends. The very rapid cooling possible with small drops discharged from a nozzle is most striking. The increasing spread between the curves for the larger drops is to be interpreted for any particular application with due regard for the distance-time curves, for distance is an important design variable. At the boiling point the thermal function curves become parallel to the temperature axis, indicating an instantaneous change of state. The slope of the thermal function curves as dependent upon the drop temperature and air state is indicative of the cooling rate in terms of operating conditions. A higher initial temperature leads to a more rapid initial cooling for the same dynamical conditions.

2. *Illustrative example:* Consider the case in which water drops of 5 mm diameter form on the underside of the slats of an atmospheric type cooling tower deck. The drop temperature as a function of distance of fall (deck spacing) for initial temperatures of 150, 125, and 100 F is desired. The effective air state in the interdeck space is 70 F and 60 per cent relative humidity. As a limiting design condition, still air will be postulated.

The elapsed time corresponding to successive distances of fall is obtained from Fig. 3 (Data of Liznar). Values of the dynamical function corresponding to these time intervals are read on Fig. 17 and are then applied as increments to the ordinate (the initial ordinate corresponds to the initial drop temperature) of the thermal function curve which is presented on the same plot for each of the specified initial temperatures. Successive magnitudes of the drop temperature are thereby determined directly.

The predicted performance is plotted in Fig. 18. An immediate observation is that if the drop starting at 150 F were stopped at the distances of fall corresponding to 125 and 100 F its temperature after starting again would be lower than if it had continued in the uninterrupted trajectory. An interesting and practical application study is here indicated. Knowledge of the temperature changes in various types of drop impingement and re-formation processes is needed, however, to completely specify the behavior.

3. *General comments:* The application of the dynamical and thermal functions to the prediction of drop cooling should be made advisedly. Experimental proof of the validity of the computations must be awaited. Johnstone and Williams[12] present distance-velocity-time curves for drops ejected from a $\frac{3}{16}$-in. lava nozzle operating at 35 lb per square inch and discharging into a counter current gas stream moving at 5 fps. These authors also present drop size distribution data and develop a method of calculating the volume mass transfer coefficient which includes the probability of coalescence of the drops as they proceed along their trajectory.

Drop Formation From Liquid Bodies

The process of drop formation from a larger body of liquid requires the expenditure of energy for the creation of a new liquid-gas interfacial surface. This energy transfer may take place either through a spontaneous dissipation of mechanical energy on the part of the parent liquid body, or through the action of external agencies in creating conditions of surface instability which result in the separation of particles from the surface, or through a dynamic combination of the two operations. The first case is exemplified by a pressure atomizing nozzle or the shattering of a stream or drop upon impact; the second occurs when a gas stream passes at a high velocity over a liquid surface or when the action of gravity causes a pendant drop to fall from the underside of a wetted surface; the third is the most common action, being found in the dispersion of all types of liquid jets and the operation of film-forming nozzles. Data covering this subject will be presented in the complete paper appearing in TRANSACTIONS, Vol. 46, for water as the liquid, but the data are applicable to the behavior of other liquids.

Conclusion

Effective design and operation of spray nozzles require simple construction yielding a high effectiveness of energy conversion, with liquid particles of the proper size distributed throughout the reaction chamber. The behavior of drops may be predicted from the results presented herein. The results are to be considered as tentative until checked by experiment.

The ultimate goal of these researches is to present data which will allow the execution of a penetrating design of heat and material transfer equipment in terms of the predicted behavior of the small but discreet component systems whose superimposed behavior ultimately governs the macroscopic performance of the complete unit.[13]

Acknowledgments

The authors wish to acknowledge the interest exhibited in this project by the Southern California and Golden Gate Chapters of the ASHVE and the Air Conditioning Society of San Francisco.

Nomenclature

Consistent units must be used throughout.

A = projected area of drop, based on the diameter of the equivalent spherical volume.

[12] Johnstone, H. F. and Williams, G. C., *Industrial and Engineering Chemistry*, 31, 993 (1939).

[13] Nottage, H. B., Master of Science Thesis entitled, On the Evaporative Cooling of Water Drops, with a Consideration of Drop Dynamics, on file, Library, University of California, Berkeley.

$\bar{a}$ = thermal diffusivity = $\frac{k}{cp\delta}$.
C = aerodynamic resistance coefficient.
c_p = unit heat capacity at constant pressure.
d = equivalent drop diameter, or cylinder diameter.
f = unit thermal conductance.
g = gravitational constant.
k = thermal conductivity.
m = mass of drop.
P_a = partial pressure of vapor in air far away from the drop surface.
P_w = partial pressure of vapor in equilibrium with the liquid at temperature 't'.
r = latent heat of evaporation at temperature 't'.
R_v = gas constant of vapor.
R = equivalent radius of a spherical drop.
S = distance of fall or rise.
t = temperature of drop.
t_a = temperature of air-vapor mixture far away.
T_m = absolute temperature corresponding to arithmetic mean of 't' and 't_a'.
U' = overall unit mass conductance based upon concentration potential.
v = drop velocity.
$\bar{\beta}$ = coefficient of thermal expansion.
δ = weight density of fluid.
θ = time interval.
μ = absolute viscosity of fluid.
ρ = mass density of fluid.
Φ = coefficient of the thermal function, Equation (10).
ψ = coefficient of the dynamical function, Equation (9).

Dimensionless Moduli

Pr = Prandtl's modulus = $\frac{\mu c p g}{k}$

Fo = Fourier's modulus = $\frac{\bar{a}\,\theta}{R^2}$

Gr = Grashof's modulus = $\frac{d^3 \rho^2 g \bar{\beta} (t - t_a)}{\mu^2}$

Nu = Nusselt's modulus = $\frac{f_c d}{k}$

Re = Reynolds' modulus = $\frac{v d \rho}{\mu}$

Subscripts

$\rightarrow$ = relative to.
o = referring to initial condition.
c = convective heat transfer.
r = radiant energy transfer.
a = air-water vapor mixture far away from drop.
l = liquid (water).

Stoker and Boiler Setting Heights Standardized

For several years the Engineering Committee of the *Stoker Manufacturers Association* has been studying the problems of stoker and boiler setting heights and combustion space for underfeed stoker-fired boilers burning bituminous coal in capacities ranging from the smallest household unit up to machines burning 1,200 lb of coal per hour. After a series of conferences and a special field survey and test project, undertaken and completed in 1939, the Engineering Committee recommended that standard practices governing minimum setting heights be adopted by the national stoker organization in accordance with recommendations and studies made by this committee. Final action was taken by the *Stoker Manufacturers Association* at a meeting of its executive representatives in Chicago on March 12, and approval of the Engineering Committee's recommendations as to minimum setting heights was unanimously given.

This standard does not attempt to prescribe hard and fast rules governing the installation of underfeed stoker equipment in various types and sizes of boilers burning bituminous coal. It does, however, offer to the industry and to the allied trades the recommendations of the underfeed stoker industry itself as to the allowable minimum clear space between the stoker retort and the crown sheet of the boiler. These standards are based on the practical experience of the leading manufacturers, as well as dealers and installers, in the stoker industry over a period of many years covering hundreds of thousands of installations plus research work which has been conducted by the association in cooperation with national organizations in the coal industry, the boiler industry, and in cooperation with the *Smoke Prevention Association*.

There is a definite need for such standards and, while the standards cover allowable minimum heights under normal conditions and are subject to variance under local installation and operating conditions, they have been established for the purpose of assisting installers of stokers, smoke inspectors and manufacturers of boilers, to establish a guide that can be applied in a practical manner.

This new minimum setting heights standard cancels and supersedes any standards, regulations, or recommendations previously established, endorsed, or adopted by the *Stoker Manufacturers Association*.

The establishment of this standard completes the third phase in the association's program of standardization. Two other standards have been adopted by the association during the past few years, the Standard Method of Testing Stoker-Fired Steam-Heating Boilers, and Standard Methods of Rating Stokers, according to Marc G. Bluth, secretary of the association.

Fire Waste Winners

Cincinnati wins the grand award in the 1939 National Fire Waste contest. Competing with some 300 cities, having a population of 30,000,000, the winner had the best record of all cities for fire waste accomplishments. Grading was done during the week by the council's board of judges.

The contest has been conducted over a period of years by the National Fire Waste Council, in cooperation with the Chamber of Commerce of the United States. The cities entered have consistently shown a better fire prevention record than have noncompeting cities. Plaques will be awarded the winning cities at the annual meeting of the Chamber, April 29 to May 2.

Winners in the six population classes are:

Class I—Cities of more than 500,000 population—Milwaukee, Wis.

Class II—Cities of 250,000 to 500,000 population—Cincinnati, Ohio.

Class III—Cities of 100,000 to 250,000 population—Hartford, Conn.

Class IV—Cities of 50,000 to 100,000 population—Lakewood, Ohio.

Class V—Cities from 20,000 to 50,000 population—Parkersburg, W. Va.

Class VI—Cities under 20,000 population—Ridgewood, N. J.

In addition to the winners, 60 cities received honorable mention for outstanding work in fire prevention and protection.

Smoke Prevention Association Convenes May 21 in St. Louis

According to F. A. Chambers, secretary-treasurer of the *Smoke Prevention Association* and chief smoke inspector of Chicago, the attendance at the forthcoming 34th annual convention of the association, to be held at the Hotel Statler, St. Louis, gives every indication of being the largest in its history.

The opening session will convene at 2:00 p. m., Tuesday, May 21, with an address by Reinhard Kunz, president of the association, and an address of welcome by the Honorable Bernard F. Dickman, Mayor of St. Louis.

Among the speakers at the various sessions are the following: W. E. E. Koepler, secretary, *Pocahontas Operators Association*; R. R. Tucker, St. Louis Smoke Commissioner; R. J. Piersol, Illinois State Geological Survey, who will discuss "Smoke Index—A Quantitative Measurement of Smoke"; Ralph Johansen, president, Hays Institute of Combustion, has chosen the subject of "The Law as Applied to Air Pollution." One of the outstanding features on Wednesday's program will be a panel discussion entitled, "Hand Firing Heating Equipment with Different Kinds of Coal." W. G. Christy, smoke abatement engineer, Hudson County, N. J., will act as chairman during a panel discussion on Railroad Locomotive Smoke Abatement. H. K. Kugel, chief engineer, division of Smoke Regulation and Boiler Inspection, Washington, D. C., will preside over a conference of City Smoke Inspectors.

SUMMER MEETING

ARRANGEMENTS

W. H. Littleford

M. T. Firestone

T. H. Urdahl

I. M. Day

H. H. Downes

F. E. Spurney

S. P. Eagleton

S. L. Gregg

P. H. Loughran, Jr.

COMMITTEE

P. H. Erisman, Jr.

W. E. Kingswell

G. R. Walz

R. K. Thulman

D. B. Tuxhorn

Photographs by Harris & Ewing

Washington Wants to See You...in June

Committee on Arrangements

T. H. Urdahl, *Chairman*

TECHNICAL SESSIONS—R. K. Thulman, *Chairman.*
INSPECTION TRIPS—S. P. Eagleton, *Chairman.*
TRANSPORTATION—D. B. Tuxhorn, *Chairman.*
REGISTRATION-RECEPTION—S. L. Gregg, *Chairman.*
PUBLICITY—M. T. Firestone, *Chairman.*
ATTENDANCE—W. H. Littleford, *Chairman.*
ENTERTAINMENT—I. M. Day, *Chairman.*
FISHING—Col. H. H. Downes, *Chairman.*
FINANCE—G. R. Walz, *Chairman.*
BANQUET—F. E. Spurney, *Chairman.*
GOLF—W. E. Kingswell, *Chairman.*
SIGHTSEEING—P. H. Erisman, Jr., *Chairman.*
LADIES—P. H. Loughran, Jr., *Chairman.*

ALL roads lead to Washington, D. C., where the Society's Semi-Annual Meeting 1940 will be held, June 17 to 19, at the Wardman Park Hotel. The Committee on Arrangements has announced that plans are now complete for the entertainment of visiting members and everyone is urged to come and bring the entire family, because Washington and nearby Virginia and Maryland have many places of historic and educational interest for all.

The headquarters hotel is located in a private park with every facility for entertainment. Though well away from the downtown district the taxi rate from the Union Station is 30 cents. Room rates are low and the cost of bringing the entire family is moderate because of the special rates available for children. For those members who drive there is ample free parking space at the hotel, also special garage and service facilities if desired. The location is close to the Bureau of Standards, golf clubs and other points of interest.

Service at the Wardman Park Hotel is on the European Plan and the special rates for members attending the Semi-Annual Meeting are Single room and bath $3.00 per person per day and Double room and bath (2 persons) $5.00 per day. Rates for special suites will be quoted on application. Every room is an outside room and the hotel, one of the largest in the south, is attractively furnished and provides excellent dining service at moderate rates. The hotel overlooks Rock Creek Park and points of interest in the vicinity at the National Zoological Park, the U. S. Naval Observatory and Washington Cathedral.

The time selected for the meeting will find Washington in its best summer dress and sessions have been arranged so that there will be plenty of time to see all of the sights.

The railroads quote low round trip fares to Washington and the cost of a round trip from a few typical chapter cities is given:

Round Trip R. R. Fare	To Washington From	One Way Pullman Lower Berth
$42.45	Chicago	$5.80
31.80	Cincinnati	3.95
25.00	Cleveland	3.15
33.70	Detroit	4.50
7.95	Philadelphia	2.65
17.50	Pittsburgh	2.65
48.99	St. Louis	6.30

No doubt, many members will want to continue to the New York World's Fair in connection with their visit to Washington and local agents should be asked for rates to New York as special low rate round trip World's Fair tickets may be used via Washington in either direction. Inquire about the substantial savings available when World's Fair tickets are used.

For those who motor from New England and the northeast U. S. 1 can be used and downtown traffic can be avoided. Members from southeast will find U. S. 1 or Route 211 satisfactory. Those coming from Pittsburgh and the West should use route 240. The mileage to Washington from some typical cities is as follows:

Buffalo, N. Y.	422	Louisville, Ky.	657
Chicago, Ill.	710	New York City	238
Cincinnati, Ohio	498	Philadelphia, Pa.	142
Detroit, Mich.	532	Pittsburgh, Pa.	283
Indianapolis, Ind.	543	Richmond, Va.	110

Members are receiving literature about the meeting in the form of a booklet, "Highlights of the Nation's Capital," announcement of the facilities at the headquarters hotel and room reservation card, also special cards for use in obtaining automobile routes and road information.

The Committee on Arrangements has announced that for the entertainment of visiting members there will be a fishing party on Chesapeake Bay on Sunday, June 16, and those who are interested should send their reservation in advance.

Registration headquarters will be open at the Wardman Park Hotel Monday, June 17, and the first session will be held at 10:00 a. m. During the morning, the ladies will visit the White House and in the afternoon they will join the men for a sightseeing tour. Golfers will go to Congressional Country Club, to play in a tournament for the Chapter and Research Cups during the afternoon. There will be an informal party and local chapter members are hard at work rehearsing an original playlet entitled, "Going With the Wind."

While the men are attending the technical session Tuesday morning the ladies will enjoy a motor tour to the Lee mansion, Arlington, and will have luncheon at Mt. Vernon. During the afternoon, there will be a demonstration by the F.B.I. for members and ladies. In the evening the Semi-Annual Banquet and Dance will be held at the Wardman Park Hotel.

On Wednesday morning, the ladies will attend a style show at one of the leading department stores and a program of inspection trips has been arranged for the afternoon. Plan now for three interesting days in Washington.

The Officers of the Washington Chapter and the Committee on Arrangements are hoping for a large attendance and invite their fellow-members to make plans to attend this important meeting on June 17 to 19th.

Harris & Ewing

Library of Congress Annex

TENTATIVE PROGRAM

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS

Semi-Annual Meeting 1940

Wardman Park Hotel — Washington, D. C.

June 17-19, 1940

Sunday, June 16

8:30 a. m. Fishing Party in Chesapeake Bay ($2.50 per person)

1:30 p. m. Council Meeting

Monday, June 17

8:30 a. m. Registration

10:00 a. m. TECHNICAL SESSION

Study of Changes in Temperature and Water Vapor Content of Respired Air in the Nasal Cavity, by L. E. Seeley

Heat Transmittance Through Glass Block Construction, by F. C. Houghten and David Shore

10:30 a. m. Ladies' Visit to White House, returning to Wardman Park Hotel at 12:15

1:30 p. m. Golf Tournament for Research and Chapter Cups, Congressional Country Club (Greens Fee $2.00)

2:00 p. m. Tour of Inspection, Bureau of Standards

2:30 p. m. Sightseeing Tour of downtown buildings

9:00 p. m. Informal Party and Show (an original playlet, "Going With the Wind," written and presented by members of the Washington, D. C. Chapter)—Dancing after Show

Tuesday, June 18

9:30 a. m. Ladies' Motor Tour to Lee Mansion, Mount Vernon and Arlington with luncheon at Mount Vernon

10:00 a. m. TECHNICAL SESSION

Summer Cooling Load as Affected by Heat Gain Through Dry, Sprinkled and Water Covered Roofs, by F. C. Houghten

Summer Cooling Requirements of 745 Clerks in an Office Building, by Dr. W. J. McConnell

Fever Therapy Locally Induced by Conditioned Air, by Dr. M. B. Ferderber, F. C. Houghten and Carl Gutberlet

1:30 p. m. Golf, Congressional Country Club

2:30 p. m. Tour through Federal Bureau of Investigation, U. S. Department of Justice

2:30 p. m. Ladies Card Party

7:00 p. m. Semi-Annual Banquet and Dance

Wednesday, June 19

10:00 a. m. TECHNICAL SESSION

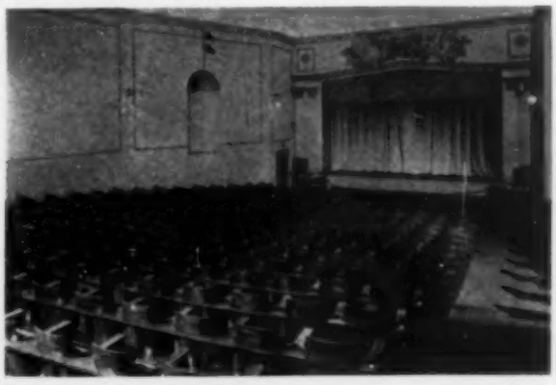
Heat Transfer Problems in Connection with the Problem of the Psychrometer, by H. B. Nottage

Development and Calibration of Instruments for Air Distribution Studies, by A. P. Kratz and A. E. Hershey

Air Flow Through Supply and Exhaust Openings in Buildings, by G. L. Tuve

10:30 a. m. Style Show for Ladies—Shopping Tour

1:30 p. m. Inspection trips to Naval Testing Basin, Carderock, Maryland Central Heating Plant, Capitol Power Plant, and Air Conditioning Systems



Wardman Park Theater

President Giesecke Addresses Minnesota Chapter

April 8, 1940. The Minnesota Chapter gathered for dinner at the Y. M. C. A. in honor of Pres. F. E. Giesecke, College Station, Tex. There were 95 members and guests in attendance when Pres. F. C. Winterer called the meeting to order at 7:15, and the minutes of the March meeting were read and approved. The report of the nominating committee was then submitted as follows: *President*—M. H. Bjerken; *Vice-President*—H. M. Betts; *Secretary-Treasurer*—D. B. Anderson; *Board of Governors*—F. C. Winterer and William McNamara. Prof. F. B. Rowley moved that the report be accepted, which was seconded and passed.

H. E. Gerrish moved that the sum of $50.00 of the Chapter's funds be earmarked and set aside as of this date for the purpose of promoting student memberships as the executive board may direct. The motion was seconded by Professor Rowley and considerable discussion followed. Professor Rowley called attention to the fact that when student members received both their membership and THE GUIDE for $3.50 the Society had quite a number of student members, but when the dues were raised to the present amount the student membership showed a very decided drop. He further stated that the students of today are excellent prospects for future membership and urged everything possible to encourage them. He based his conclusion on the fact that past experience indicates a large percentage of student members continued on with the Society to full membership. J. E. Swenson suggested that since student members are present for only a year or two at best, he would prefer to see the money expended in the nature of a scholarship for needy students. Prof. A. B. Algren suggested that the matter be considered further at the next meeting.

F. H. Shernbeck, chairman of the entertainment committee, announced that the May meeting would be held at the Golden Valley Golf Club, May 13.

President Winterer then called upon Professor Rowley to introduce the guest speaker of the evening, Pres. F. E. Giesecke, whose subject was "Radiant Heating and Cooling." He opened his remarks with a brief resumé of the growth of membership in the Society, and explained the necessity of a continued healthy growth of the Society through its Chapters. He then presented his subject in a very thorough manner, carefully explaining and illustrating the fundamental principles of this method of heating and cooling and traced its historical development from its inception many years ago, to the more modern applications in both Europe and America. He also explained and illustrated many details of construction involving different heating and cooling media. The meeting adjourned at 9:30 p. m. with a rising vote of thanks to Professor Giesecke for a most enjoyable evening.

Philadelphia Holds Annual Meeting

April 11, 1940. The annual meeting of the Philadelphia Chapter was held at the Anthracite Industries Laboratories, Primos, Delaware County, Pa. Following an excellent supper the meeting was called to order at 7:30 p. m. by Pres. R. F. Hunger. The reading of the minutes of the previous meeting was dispensed with.

A. C. Caldwell announced that the auditing committee had examined the accounts of the Treasurer and found everything in order. Treasurer Mather then read a summary of the audit, dated April 1, 1940.

H. B. Hedges then explained the arrangements for the annual golf meeting at Huntingdon Valley Golf Club on May 9, 1940, and W. P. Culbert spoke briefly concerning the plans of the golf committee for that day.

The list of names selected by the nominating committee to serve as the officers of the chapter were then announced by President Hunger as follows: *President*—C. B. Eastman; *First Vice-President*—H. B. Hedges; *Second Vice-President*—H. H. Mather; *Treasurer*—Edwin Elliot; *Secretary*—A. C. Caldwell; *Board of Governors*—R. F. Hunger and L. E. Moody.

Mr. Hedges then presented the host of the evening, Allen J. Johnson, director of the Anthracite Institute Laboratories, who briefly outlined the work of the Institute. His talk was followed by a tour of inspection of the Laboratories guided by engineers of the staff, and enjoyed by the 85 members and guests attending.

Western New York Host to T. F. Hatch and F. J. Linsenmeyer

April 8, 1940. The regular meeting of the Western New York Chapter was held at the University Club with 118 members and guests attending.

The reading of the minutes of the March meeting was dispensed with, due to the length of the evening's program. Pres. L. P. Saunders read a letter received from the family of the late Benjamin F. Stangland, expressing their grateful appreciation for the kind expression of sympathy in their recent bereavement.

The secretary read the slate of officers for 1940-41 as adopted by the Board of Governors at a meeting held March 21, as follows: *President*—C. A. Gifford; *First Vice-President*—W. R. Heath; *Second Vice-President*—H. C. Schafer; *Secretary*—S. M. Quackenbush; *Treasurer*—B. C. Candee.

President Saunders appointed M. C. Beman to audit the Treasurer's books for 1939-40. Mr. Gifford announced that the May meeting would be the annual meeting and that the Chapter would be the guest of the Iroquois Gas Corp.

After President Saunders introduced the various officers and guests seated at the speaker's table, he introduced Theodore F. Hatch, New York, N. Y., associate dust control engineer, Division of Hygiene, New York State Labor Department, who chose as his subject dust control. His talk was very interesting and instructive and was accompanied by lantern slides. The subject being of interest to so many industries of Western New York, a large number of key men who have industrial problems were in attendance. A rising vote of thanks was extended to Mr. Hatch, after which the meeting was adjourned.

March 11, 1940. The March meeting of the Western New York Chapter was held at the University Club with 34 members and guests attending.

The minutes of the previous meeting were read and approved. Pres. L. P. Saunders read a letter from J. R. Vernon, expressing his appreciation to the Chapter for the courtesies extended to him when he was the guest speaker at the February meeting.

Walter Davis spoke briefly on the identical bills introduced in the Senate and Assembly in the State of New York, Albany, No. 317 in the Senate and No. 420 in the Assembly. These bills provide for the licensing of contractors in the air conditioning field, and it was regularly moved and seconded that the Chapter definitely sanction these bills.

A vote of thanks was given to the dance committee, Roswell Farnham, Joseph Davis and D. J. Mahoney, for their splendid efforts in arranging for the Washington Birthday dinner-dance at the Park Lane, the proceeds of which Mr. Farnham turned over to the chapter.

Mr. Farnham spoke in connection with the outline of the April meeting and announced the guest speaker as Theodore Hatch, New York City, associate dust control engineer, State of New York, Department of Labor, who will discuss industrial ventilating problems.

President Saunders then introduced the guest of the evening, Prof. F. J. Linsenmeyer, University of Detroit, who chose as his subject air leakage through full metal weatherstripped windows. His talk was very interesting and instructive, accompanied by lantern slides. A rising vote of thanks was extended Professor Linsenmeyer, after which the meeting was adjourned.

Insulation Discussed at Pittsburgh

April 8, 1940. Following dinner in the Coffee Shop of the Roosevelt Hotel, Pres. F. C. McIntosh called the regular meeting of the Pittsburgh Chapter to order with 35 members and guests present. The minutes of the March meeting were read and approved as read.

President McIntosh reported on several meetings of the Advisory Board to discuss a research program which the Pittsburgh Chapter desired authority to sponsor.

F. C. Houghten reviewed what had already been done at the Magee Hospital in the way of air conditioning the operating room and recovery ward.

President McIntosh then introduced Dr. M. B. Ferderber, who discussed some of the problems of preparing a patient for an operation, particularly in summer and of the precautions generally taken to avoid post-operative shock. He then presented Dr. John W. Shires, who is an authority on pre-operative preparation and post-operative treatment. He spoke briefly on what he hoped might be gained from more accurate knowledge of the effect of atmospheric environment on a patient before, during, and after a major operation.

President McIntosh introduced the principal speaker of the evening, Paul D. Close, Chicago, technical secretary of the Insulation Board Institute. Mr. Close's visit to the Pittsburgh Chapter was arranged through the courtesy of the Speaker's Bureau of the Society. He addressed the meeting on the topic of "Heat that Hesitates," reviewing some of the fundamentals of heat transfer and the characteristics of the several types of insulation. This was followed by a discussion of the economies of insulation in building construction. As customary the question of how thick insulation should be provoked an energetic discussion. According to T. F. Rockwell, secretary of the chapter, the meeting adjourned at 10:30 p. m.

Storage Refrigeration Interests New Orleans Chapter

April 17, 1940. The regular meeting of the Delta Chapter was held in the New Orleans Public Service Bldg., and was well attended and thoroughly enjoyed by the members and guests present, according to F. G. Burns, secretary of the Chapter.

Carl F. Boester, Jr., St. Louis, Mo., was the guest speaker and his talk on the subject of storage refrigeration as applied to air conditioning was enthusiastically received and the barrage of interesting questions from the floor continued for over an hour. The Delta Chapter complimented the Speaker's Bureau of the Society for its fine selection, and for affording the members in New Orleans the opportunity to hear Mr. Boester.

Oregon Elects New Officers

March 7, 1940. Pres. J. D. Kroeker called the meeting to order with 24 members and guests in attendance. The minutes of both the January and February regular meetings were approved as read.

Vice-Pres. T. E. Taylor presented a complete report of activities as well as exhibits at the Annual Meeting and Exposition in Cleveland, which was followed by a lengthy discussion, at the conclusion of which Mr. Taylor was complimented by the chapter for his fine report.

J. L. Byrne, as chairman of the legislative committee, reported that his committee had again met, and had instructed the president to arrange a meeting with Commissioner Bowes of the Portland City Council.

President Kroeker called upon B. W. Farnes, who reported on future meetings, and announced that the banquet meeting at the Air Conditioning Conference was to be the next chapter meeting, and that Prof. F. E. Giesecke, president of the Society, would address the group at that time.

J. F. McIndoe reported the public relations committee had met, and that a newspaper article had been drawn up and presented to the "Oregonian" for possible release.

Prof. E. C. Willey announced that the program for the Air Conditioning Conference had been completed, and called upon B. W. Moore to report as chairman of the program committee.

Following a report by J. E. Yates, on action taken by his research committee with regard to the possible research to be carried on at Oregon State College, C. M. MacGregor reported on the publicity received in connection with the Conference.

Mr. Taylor reported that the by-laws had been rewritten to agree with the Society's ideas with the exception of the matter of incorporating.

The names of the candidates for the Chapter's officers were read and unanimously elected as follows:

President—T. E. Taylor.
Vice-President—J. F. McIndoe.
Treasurer—C. M. MacGregor.
Secretary—B. W. Moore.
Board of Governors—W. T. Finnigan, J. D. Kroeker and J. Albert Freeman.

J. D. Kroeker was elected as alternate delegate.

After the secretary read a letter written to the Senators and Representatives urging the passing of House Bill No. 4500, there being no further business, the meeting was declared adjourned.

Iowa-Nebraska Host to Prof. Eastwood

March 18, 1940. The March meeting of the Iowa-Nebraska Chapter of the Society was held at the Chamberlain Hotel, Des Moines, Ia., with dinner preceding the meeting which was attended by 21 members and guests and called to order by Pres. T. R. Johnson.

Following the reading of the minutes of the February meeting, which were approved as read, the secretary made a report on the national and chapter membership for Iowa and Nebraska. President Johnson reported on the progress of the application for a separate Iowa Chapter. N. D. Adams, Rochester, Minn., chairman of the Society's Membership Committee, was present to assist in organizing the proposed Iowa Chapter. Mr. Adams stated that the information he was able to obtain from the Omaha and Des Moines meetings indicated that there was almost 100 per cent attendance from the state in which the meetings were held. He further explained that the members in Omaha had already prepared a petition for a separate chapter and suggested that the Iowa members proceed with their petition and send it in to the Council of the Society for approval. He also suggested that the Iowa-Nebraska Chapter continue to function for the remainder of this year and start the new separate chapters in October. Mr. Adams then read a very interesting paper describing the benefits derived from belonging to the Society.

A. L. Walters introduced the guest of the evening, Prof. E. O. Eastwood, head of mechanical engineering department at the University of Washington, Seattle, and 2nd Vice-President of the ASHVE, and gave an outline of Professor Eastwood's past accomplishments. Professor Eastwood, in opening his remarks, stated that he was making a tour of the country visiting several local chapters, and that the purpose of the trip was to acquaint the officers of the Society with the work which is being done in different local chapters throughout the country. He outlined briefly the history of the Society and talked about the progress of engineering, from the old Greek philosophers down to the present time. He also outlined the present research program of 24 projects and stated that among the investigations were study of glass blocks, fuels, stokers, duct friction, insulation, and many other subjects. He briefly described the wind tunnel at the University of Washington and the experimental work being done there for the Government in connection with airplane research.

In discussing chapter programs he stated that they should appeal to the following divisions of engineering: consulting, sale and manufacturing. In discussing the requirements of an engi-

neer, he touched upon the psychology of human nature, personality and desire to experiment. He further discussed the future of the engineer, stating that the future of man is very closely related to the future of engineering as the economical handling of the materials of the earth will determine to a great extent the length of time mankind will be able to live on the earth. He concluded his talk by referring to the practical information contained in THE GUIDE, and then answered the numerous questions.

Mr. McAlweede, City Inspector for the City of Des Moines, was present and asked the Society's assistance in the smoke problem in Des Moines. Much discussion followed this request, and Professor Eastwood suggested the appointment of a committee to investigate and see if an engineering problem exists in the connection. President Johnson immediately appointed Maurice Olchoff, A. L. Walters and N. B. Delavan to serve on such a committee. According to Perry La Rue, secretary of the Chapter, the meeting adjourned at 10:30 p. m.

F. J. Linsenmeyer Visits Ontario

April 1, 1940. The April meeting of the Ontario Chapter was held at the Royal York Hotel, Toronto, with 40 members and guests in attendance. Following dinner the secretary read the minutes of the preceding meeting, which were approved as read.

The report of the nominating committee was then announced as follows: *President*—J. W. O'Neill; *Vice-president*—F. E. Ellis; *Secretary*—H. R. Roth; *Board of Governors*—C. Tasker, D. O. Price, and W. C. Kelly.

Pres. H. D. Henion announced that the auditors for the coming year would be W. C. Kelly and D. O. Price. President Henion then called upon P. H. Foster, a member of the Manitoba Chapter, who extended greetings from his chapter.

Prof. F. J. Linsenmeyer, University of Detroit, was introduced by President Henion, and spoke on air leakage through full metal weatherstripped windows. He illustrated his talk with slides showing the various types of window construction, which proved very interesting. A vote of thanks on behalf of the chapter was extended Professor Linsenmeyer for his splendid address, which was followed by adjournment.

Air Conditioning Discussed by Manitoba Chapter

March 21, 1940. The regular monthly meeting of the Manitoba Chapter was held at the Fort Garry Hotel, Winnipeg, and Pres. G. C. Davis called the meeting to order at 6:45, with dinner preceding the meeting. The minutes of the February meeting were read and approved on motions of Messrs. Michie and Charles.

The standing committees were requested to prepare and submit a report of the year's activities at the May annual meeting. A discussion relative to a letter from the Board of Trade of the City of Toronto regarding the term "air conditioning" followed, and President Davis was requested to reply stating in effect that the Manitoba Chapter was still in accord with their previous recommendations.

D. F. Michie, William Worton and William Glass were appointed to the nominating committee to select candidates for the various offices to be filled at the May meeting, with nominations available for the April meeting. It was announced that Prof. F. E. Giesecke, president of the Society, would be the speaker at the April meeting. There being no further business the meeting was adjourned.

February 23, 1940. A special dinner meeting of the Manitoba Chapter was held at the Marlborough Hotel, Winnipeg, with President Davis presiding. The minutes of the preceding meeting were read and on motions of J. B. Steele and F. Chester were approved as read.

The secretary read a letter received from P. H. Foster, now with the Royal Air Force, in which Mr. Foster expressed his thanks to the Manitoba Chapter.

Following the regular order of business President Davis introduced Dr. Charles Sheard, director, division of physics and biophysical research, The Mayo Foundation and Clinic, Rochester, Minn. Dr. Sheard gave an interesting address, illustrated by lantern slides, on the subject of thermal interchanges between the human body and its environments. After a vote of thanks to Dr. Sheard, extended on behalf of the chapter by P. L. Charles, the meeting was adjourned.

Glass Insulation and Odor Control Discussed at Cincinnati Meetings

March 12, 1940. A group of 28 members of the Cincinnati Chapter boarded a Greyhound bus for Newark, Ohio, where they were courteously escorted through the Owens-Corning Fiberglas Plant. The inspection trip revealed the intricate manufacturing methods necessary to produce glass insulation, glass air filters, and glass cloth.

Dinner was served in the Granville Inn, Granville, Ohio, with the compliments of the hospitable Owens-Corning officials, who gave short talks on the various phases of their glass products, manufacturing and application, as was reported by W. H. Junker, secretary of the Cincinnati Chapter.

February 13, 1940. The regular monthly meeting was held at the Netherland Plaza, in spite of a severe blizzard and low temperature, and the 27 members and guests present gave a warm welcome to Henry Sleik, vice-president, W. B. Connor Engineering Corp., who gave an interesting talk on odor control, with particular attention to activated carbon in the air stream.

The routine business included the reading and approval of the minutes of the previous regular meeting, a discussion of the March meeting to be in the form of an inspection trip to the Owens-Corning Fiberglas Corp., Newark, Ohio. The election of the nominating committee resulted in the following: O. W. Motz, chairman; H. A. Pillen, R. W. Sigmund, I. B. Helburn and E. B. Royer. The chapter delegates' meeting in Cleveland was also discussed.

Pres. H. E. Sproull appointed the following as official chapter representatives in connection with the proposed revisions of the Cincinnati Building Code, with particular reference to the Heating, Ventilating and Air Conditioning provisions of the Code: O. W. Motz, I. B. Helburn, M. E. Mathewson, W. R. Stevens and W. H. Junker.

Before adjournment G. P. Mursinna showed a movie film of the annual dinner-dance, which was enjoyed by all.

January 20, 1940. The Cincinnati Chapter declared a holiday from serious business and under the stewardship of Hal K. Jennings, held a dinner-dance in the Alms Hotel. There were 75 members and guests who enjoyed a delicious dinner and then tripped the light fantastic for the remainder of the evening.

Illinois Chapter Hears W. H. Driscoll

February 12, 1940. The February meeting of the Illinois Chapter was called to order at 8:00 p.m. by Pres. Tom Brown, with an attendance of 67 members and guests. The secretary read the minutes of the previous meeting and gave his report to the chapter on the Society's Annual Meeting in Cleveland. President Brown read a letter from the Delta Chapter, New Orleans, expressing their appreciation of the Illinois Chapter's message of congratulation on their organization.

H. M. Hart, past president of the Society, introduced W. H. Driscoll, New York, another past president, whose subject was amputating the square foot. Mr. Driscoll opened his talk with several interesting reminiscences of the early days of the Society and sketched its birth and development from its organ-

ization in 1894. He told of the start of the Research Laboratory and brought out the fact that this was the first Society of its kind to increase its annual dues for the specific purpose of supporting a Research Laboratory. Mr. Driscoll stressed the importance of the Research Laboratory, not only to every member of the Society but to everyone engaged in the heating, ventilating and air conditioning field.

He also gave some interesting facts about the first GUIDE in 1922 and sketched the growth of THE GUIDE to the present time.

He discussed the origin of the term "square foot" in the nomenclature to express a unit of heating and outlined the progress being made toward eliminating this term, which no longer has any relation to the quantity it represents and the substitution of the symbol "Mb" or "Mbh," *i.e.* 1,000 Btu or 1,000 Btu per hour. He also pointed out that the use of this unit would simplify calculations in both heating and cooling problems.

Mr. Driscoll closed his remarks by lauding the life-long efforts of such Illinois Chapter members as H. M. Hart, S. R. Lewis and John Howatt, and their continued interest in the ASHVE after retirement from the presidency of the Society.

A lively discussion followed, and J. J. Aeberly moved that the secretary inform the Standards Committee that the Illinois Chapter was in favor of the adoption of the symbol "Mbh" and elimination of the term "square foot." The motion was seconded and unanimously carried, and was followed by adjournment.

Air Conditioning Conference at Oregon State

The third Oregon State Air Conditioning Conference, sponsored by the Oregon State College, Corvallis, Ore., was held March 28-30, 1940, with the Oregon Chapter of the ASHVE cooperating in arranging the technical program.

Earl C. Willey served as General Chairman of the Conference Committee, and was assisted by John P. McDermott, Bryant W. Moore, Cecil M. MacGregor, C. E. Thomas, Walter Hanthorn and J. Donald Kroeker.

The attendance of 135 specialists in the fields of heating, ventilating and air conditioning was from all parts of the country, and the latest developments in air conditioning equipment and its proper application were discussed. There were 15 papers presented during the 11 sessions of the Conference. Among the subjects discussed were, economics of heating, radiator heat, warm air heating, installation codes, control systems, fuels, oil burners, district heating, problems of condensation, radiant heating, air distribution and grilles, cooling methods, and modernization of heating systems.

Numerous exhibits on air conditioning units, heaters, coolers, fans, control equipment, etc., were on display in the Mechanical Engineering Laboratory, and this feature aided in establishing closer cooperation and understanding with those in the construction fields, the products of which are so vitally affected by air conditioning.

The opening session was held in the Chemistry Building auditorium with Earl C. Willey presiding as chairman. Dean R. H. Dearborn, School of Engineering, welcomed the guests, and Prof. S. H. Graf, mechanical engineering department at the College, and J. Donald Kroeker, president of the Oregon Chapter of the Society, also greeted those attending the Conference. The chairmen of the technical sessions were Messrs. Willey and Moore.

The Oregon Chapter of the ASHVE held their regular monthly meeting, in conjunction with the Conference, on March 29, and the program started at 6:00 p. m. with a stag banquet at which B. W. Farnes acted as toastmaster. Greetings were given by George W. Peavy, president of Oregon State College, and at 7:30 p. m. an illustrated lecture on "Radiant Heating and Cooling" was presented by Prof. F. E. Giesecke, College Station, Tex., president of the ASHVE. After a discussion period the installation of the newly elected officers of the Oregon Chapter of ASHVE was completed.

Arrangements for 1941 Annual Meeting Announced

John M. Arthur, Jr., has been appointed General Chairman of the Committee on Arrangements for Kansas City Chapter to plan the entertainment program for the 47th Annual Meeting of the Society to be held in Kansas City, Mo., January 1941. According to Mr. Arthur the local committee will endeavor to make this meeting one of the best in a long series of successful meetings held by the Society. Already the local committees are functioning with enthusiasm and thoroughness, and the chairman promises that the Kansas City Annual Meeting, from the housing and entertainment standpoint will be most enjoyable.

Serving with Mr. Arthur are W. L. Cassell, co-chairman and Anson D. Marston, vice-chairman, D. M. Allen, Melvin A. Disney, Forrest F. Dodds, Nate W. Downes, Henry E. Gould, Edward M. Jolley, J. E. Matthews, Henry Nottberg, Jr., Mrs. William A. Russell, F. A. Sheppard and L. A. Stephenson.

Prof. Eastwood Entertained by Georgia Tech Faculty

The Research Club of Georgia Tech composed of faculty members interested in research and headed by Harry Vaughn, director, Experimental Station, held a dinner at Georgia Tech, March 20, in honor of Prof. E. O. Eastwood, 2nd Vice-President of the ASHVE and head of department of mechanical engineering, University of Washington, Seattle. Professor Eastwood is also director of the Guggenheim Aeronautics Laboratories at the University of Washington, and chairman of the Board of Directors of the University Bank of Seattle.

His visit to Georgia Tech was arranged through the courtesy of the Atlanta Chapter of the ASHVE at whose meeting Professor Eastwood was the featured speaker March 21, when he spoke on the subject of the economic future of the engineer.

Hot Water Heating Research

Trends toward forced hot water heating for large housing developments and the economic possibilities of small piping connections necessitate immediate research investigations in the opinion of A. E. Stacey, Jr., New York, N. Y., chairman of the ASHVE Committee on Research. In consideration of the demands for more accurate engineering data on the frictional resistance of large pipe sizes a Research Technical Advisory Committee on Flow of Fluids through Pipes and Fittings has been appointed with S. R. Lewis, consulting engineer, Chicago, Ill., and past president of the Society, as chairman. Arrangements have been made to conduct the first experimental investigation under a cooperative agreement with the Society at the Texas Agricultural & Mechanical College, College Station, Tex., where Dr. F. E. Giesecke, now president of the Society, will personally supervise the research program.

Formulae for flow of cold water in municipal supply systems, developed by recognized authorities in Europe and America, make a substantial allowance for the gradual accumulations of debris inside the pipes due to mud and encrustations. However, at the present time piping systems designed for hot water heating rarely make any allowance for increased resistance to flow or for progressive reduction in capacity due to roughening of an originally smooth interior or for constriction by mud and scale.

Tests conducted at the Society Research Laboratory in Pittsburgh some years ago disclosed that little difference exists between resistance to the flow of fluid in steel or copper pipes because of their same relative smoothness, but that resistance increases rapidly if the interior surface is roughened for any reason. Data on sizing hot water piping for heating given in the HEATING VENTILATING AIR CONDITIONING GUIDE were developed as the result of investigations on comparatively small pipes and

there has been no evidence but that these data are conservative. However, with the rapid increase in use of large hot water heating systems it seems desirable to restudy the frictional resistance for pipe sizes larger than 6 in. in diameter, as the GUIDE data were computed from friction drops disclosed in much smaller pipes.

Other members of the committee who are responsible for outlining and supervising this work are: L. A. Cherry, Buffalo, N. Y.; G. C. Davis, Winnipeg, Man., Canada; T. M. Dugan, McKeesport, Pa.; Earle W. Gray, Oklahoma City, Okla.; R. T. Kern, Fitchburg, Mass.; H. A. Lockhart, Chicago, Ill.; Axel Marin, Ann Arbor, Mich.; R. F. Taylor, Houston, Tex.; and E. L. Weber, Seattle, Wash.

R. R. Sayers Named Director of Bureau of Mines

Dr. R. R. Sayers, senior surgeon of the U. S. Public Health Service, who for 17 years directed the health and safety activities of the Bureau of Mines, has been appointed director of the Bureau to succeed John W. Finch, who resigned January 31.

Dr. Sayers, a graduate of the Universities of Indiana and Buffalo, was professor of electro-chemistry at Buffalo University before joining the Public Health Service. Since the Bureau of Mines took over direction of its own safety operations in 1932 he has been in charge of industrial hygiene and sanitation for the U. S. Public Health Service. He is a member of the *American Institute of Mining and Metallurgical Engineers* and is the author of several books on mining and metallurgy.

Death of Robert P. Rasmussen

Robert P. Rasmussen, president of the Economy Equipment Co., Chicago, Ill., died on February 2, 1940, in his fifty-second year. His death came suddenly of a heart attack and was a great shock to his many associates. He had been active in the business until a few days prior to his death.

Mr. Rasmussen, formerly associated with the Bentz Engineering Co., Newark, N. J., manufacturers of air conditioning equipment, and western manager of the company at the time they discontinued business, was born in Chicago on July 2, 1888, where he received his early education. He attended the University of Michigan, Northwestern University, Armour Institute of Technology and the University of Illinois. All through his career as a student and business man he was recognized as a man of ability and of untiring efforts.

In 1928 he decided to take advantage of the experience received with the Bentz Co., and the Economy Equipment Co. was organized.

He is survived by his widow, a daughter, Marilyn, a son, Robert, and three brothers, H. E. Rasmussen, A. F. Rasmussen and E. L. Rasmussen, to whom the Officers and Council of the Society extend their deepest sympathy.

B. F. Stangland, Charter Member, Dies at 92

Benjamin F. Stangland, charter member of the ASHVE and mechanical engineer, who designed and installed ventilating plants in many of the large buildings in New York between 1879 and 1916, when he retired, died at his home, Morton, N. Y., on March 26, 1940, at the age of 92.

Mr. Stangland was born in Noble County, Ind. His early education was received in public schools and at the Brockport, N. Y., Academy. In 1871, the year of the Chicago fire, he was working in Chicago as a sales engineer for the Forsythe Scale Co. The first night of the fire, October 8, he saved the records of the company by pushing them around on a hand truck all night, keeping a step ahead of the flames, which destroyed the firm's building soon after Mr. Stangland had taken the records.

At the Philadelphia Centennial Exposition in 1876, Mr. Stangland developed the idea of counting small parts of watches by weighing them on a delicate scale, a practice continued to this day. He was sales engineer for the Fairbanks Co., manufacturers of scales, from 1873 to 1877.

From 1879 until his retirement in 1916 he was associated with Howard & Morse in New York at 45 Fulton St. He designed and installed ventilating plants in other large cities besides New York, and was an authority on ventilating and drying ovens for fruit products.

Mr. Stangland, besides being a charter member of the ASHVE, was a member of the *American Society of Mechanical Engineers*, of which he became a fifty-year member last December.

Surviving are his wife, Mrs. Emily Bridgeman Stangland, whom he married 64 years ago; a son, Robert Sedgwick Stangland, Yonkers, N. Y., and a daughter, Mrs. Jessie Cary Grange, Morton, N. Y.

CANDIDATES FOR MEMBERSHIP

The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.

When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month 45 applications for membership have been received and the names of these men and their sponsors are published in the following list.

Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.

All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.

Unless objection is made by some member by May 15, 1940, these candidates will be balloted upon by the Council. Those elected to membership will be notified by the Secretary immediately after election.

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
BAHLMANN, W. F., Br. Mgr., Holland Furnace Co, Richmond, Va.	P. T. Cheff (*Non-Member*) F. H. Ault (*Non-Member*)	Edwin Conquest (*Non-Member*) James Moncure (*Non-Member*)

CANDIDATES	REFERENCES	
	Proposers	*Seconders*
BAYLES, R. W., Mgr. Htg. Div., James Morrison Brass Mfg. Co., Ltd., Toronto, Ont., Can.	H. D. Henion M. W. Shears	H. R. Roth H. G. Hill
BLAZER, B. V., Owner, M. Blazer & Son, Passaic, N. J.	Joseph Thieberg (*Non-Member*) H. F. Randolph (*Non-Member*)	R. F. Townsend (*Non-Member*) P. B. Reed (*Non-Member*)
BUCK, D. T., Pres., Buck Engrg. Co., Freehold, N. J. (*Advancement*)	W. H. Pond W. M. Heebner	O. O. Oaks A. L. Browne
CAIN, W. J., Student, Air Cond. & Refrig. Inst., St. Louis, Mo.	G. W. F. Myers J. W. Cooper	Paul Sodemann Lyndon Starr (*Non-Member*)
CRAIG, J. A., Sales, Trane Co., Minneapolis, Minn.	William McNamara F. C. Winterer	C. E. Gausman O. L. Lilja
DAHLGREN, G. E., Insulation Mgr., Thorkelsson, Ltd., Winnipeg, Man., Can.	G. C. Davis Ivan McDonald	J. B. Steele Paul Thorkelsson (*Non-Member*)
DEEVES, E. W., Partner, Fred Deeves & Sons, Calgary, Alta., Can.	Alfred Dion E. J. Davis	J. P. Fitzsimons H. G. Hill
DRAIN, H. E., Dist. Repr., Warren Webster & Co., Des Moines, Iowa	T. R. Johnson Perry La Rue	E. M. Bartels L. E. Hedeen
DUITCH, P. R., Sales Engr., Delavan Engrg. Co., Des Moines, Iowa	N. B. Delavan T. R. Johnson	Perry La Rue C. W. Helstrom
EVANS, R. W., Mgr. Comm. Air Cond. Dept., Conditioned Air Equip. Co., St. Paul, Minn.	L. C. Gross F. B. Rowley	H. S. Morton A. B. Algren
FOGG, J. H., Sales Engr., B. F. Sturtevant Co., Alexandria, Va.	I. M. Day W. H. Littleford	F. A. Leser T. H. Urdahl
GORGEN, R. E., Owner, Roy E. Gorgen Co., St. Paul, Minn.	William McNamara C. E. Gausman	F. C. Winterer H. E. Gerrish
GRANDIA, W. M., Charge of Air Cond. & Refrig., Pacific Commercial Co., Manila, P. I.	F. G. Walther L. F. Bourgarde (*ASRE*)	James Anderson, Jr. (*ASRE*) H. L. Consley (*Non-Member*)
GRAY, H. E., Partner, Gray Engineering Co., High Point, N. C.	M. D. Brown T. C. Cooke	L. L. Vaughan R. B. Rice
GRIFFIN, C. J., Engr.-Custodian, Chicago Board of Education, Chicago, Ill.	E. B. Ericsson J. J. Finan	John Howatt E. J. Finan (*Non-Member*)
HALL, TRUMAN, Stoker Sales & Service, Dygert Dist. Co., Grand Rapids, Mich.	T. D. Stafford W. W. Bradfield	F. C. Warren C. H. Morton
HAWES, H. D., Student, Mass. Inst. of Tech., Cambridge, Mass.	James Holt H. C. Moore	G. B. Wilkes C. M. F. Peterson
HENDRICKSON, W. B., Service Mgr., Highwood Coal Co., Inc., Englewood, N. J.	Herbert Herkimer T. C. Leonard (*Non-Member*)	J. H. Koestner (*Non-Member*) E. R. Schuelke (*Non-Member*)
HEPBURN, E. M., Br. Mgr., Empire Brass Mfg. Co., Ltd., Winnipeg, Man., Can.	R. L. Kent P. L. Charles	Ivan McDonald F. L. Chester
HILL, W. W., Engr., United Clay Prod. Co., Washington, D. C.	J. J. Nolan, Jr. M. T. Firestone	Richard Bozeman T. H. Urdahl
JANOS, W. A., Mech. Engr., Western Electric Co., New York, N. Y.	E. G. Carrier L. J. Wachs	H. L. Baker, Jr. F. C. Moses (*ASME*)
KING, J. S., Htg. Contractor, Brooklyn, N. Y.	A. F. Scott M. H. Hirsch	E. N. Sanbern E. F. Glore (*Non-Member*)
KLEIN, F. R., Asst. Mgr., Htg. Dept., Globe Machy. & Supply Co., Des Moines, Iowa	C. W. Helstrom T. R. Johnson	Perry La Rue A. L. Walters
LEVITT, L. L., Air Cond. Engr., Calvert Distilling Co., Relay, Md.	E. L. Crosby E. H. Taze	J. deB. Shepard J. E. Seiter
LEWIS, H. F., Vice-Pres. & Gen. Mgr., Harvey A. Dwight Oil Heat & Supply Co., Inc., Albany, N. Y. (*Advancement*)	R. C. Taggart T. F. Murray	H. S. Dutcher G. A. Teeling
MAST, C. M., Mgr. & Engr. Htg. Dept., Reno, Nev.	Bernhard Olson W. B. Shirley	H. A. Weil, Jr. (*Non-Member*) Joe Tognosci (*Non-Member*)
MATZEN, H. B., Cons. Mech. Engr., New York, N. Y. (*Reinstatement*)	A. E. Stacey, Jr. E. P. Heckel	A. C. Buensod S. R. Lewis
MURPHY, D. C., Sales Repr., Des Moines, Iowa	T. R. Johnson E. H. Borg	L. E. Hedeen C. W. Helstrom
NUTTING, ARTHUR, Chief Engr., American Air Filter Co., Louisville, Ky. (*Reinstatement*)	H. C. Murphy Arvin Page	M. C. Gillett John Hellstrom
PAINE, H. A., Mech. Engr., Toltz, King & Day, Inc., St. Paul, Minn.	F. C. Winterer C. E. Gausman	William McNamara R. W. Otto (*Non-Member*)
PEACOCK, HERBERT, Dist. Mgr., Carrier Corp., Washington, D. C. (*Reinstatement*)	M. T. Firestone W. H. Littleford	T. H. Urdahl F. A. Leser
PETERSON, J. R., Draftsman, Gausman & Moore, St. Paul, Minn.	D. W. Hickey C. E. Gausman	William McNamara William Sturm
PROSSER, R. G., Sales, Trane Co., Minneapolis, Minn.	William McNamara F. C. Winterer	C. E. Gausman O. L. Lilja
QUACKENBUSH, S. M., Htg., Vtg. & Air Cond. Contractor, Quackenbush Co., Buffalo, N. Y.	M. C. Beman B. C. Candee	Roswell Farnham D. J. Mahoney
RUNGE, C. H., Mgr. Sunbeam Dept., American Rad. & Stan. San. Corp., Milwaukee, Wis.	I. E. Maynard James Crombie	A. G. Kalinsky P. G. Pfriem

CANDIDATES

STEVENS, E. K., Treas., Internatl. Exposition Co., New York, N. Y.

SWENEHART, D. W., Educational Dir., Air Cond. Training Corp., Youngstown, Ohio

THOMPSON, CHARLES, Sales & Design, Builders Wholesale Supply Corp., Reno, Nev. (*Reinstatement*)

TIERNAN, J. P., In charge of Engrg. Work, Tru Way Sheet Metal Fabricators, East Orange, N. J.

TODD, M. L., Mech. Engr., Waterloo, Iowa (*Advancement*)

TONE, J. E., JR., Pres., Tone Air Cond. Co., Des Moines, Iowa

WALLIS, W. M., Htg. Contractor, Seattle, Wash.

WARD, W. J., Br. Mgr., Johnson Service Co., Des Moines, Iowa

WOODS, C. F., Sales Repr., Southern Union Utilities Co., Belleville, Tex.

REFERENCES

	Proposers	*Seconders*
STEVENS	C. F. Roth A. J. Offner	W. L. Fleisher A. V. Hutchinson
SWENEHART	J. L. Hamilton (*AIEE*) Martin Schiff (*AIEE*)	Emil Kumming (*ASME*) J. L. Woodress (*AIEE*)
THOMPSON	Lawrence Gulling (*Non-Member*) William Leavers (*Non-Member*)	Lehman Ferris (*Non-Member*) G. A. Ferris (*Non-Member*)
TIERNAN	A. A. Marks B. A. Bock (*Non-Member*)	N. S. Kampish (*Non-Member*) E. S. Smith (*Non-Member*)
TODD	J. C. Knox R. H. Anderegg	L. E. Hedeen William Goodman (*ASRE*)
TONE	T. R. Johnson Perry La Rue	E. H. Borg L. E. Hedeen
WALLIS	M. N. Musgrave R. O. Wesley	B. M. Veltman H. T. Griffith
WARD	T. R. Johnson E. H. Borg	B. E. Landes R. H. Schnell
WOODS	W. E. Stark Ross Zumwalt	C. L. Kribs, Jr. H. C. Frizzell (*AGA*)

CANDIDATES ELECTED

In the past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

MEMBERS

BERTOLETTE, CHESTER, JR., Htg. & Air Cond., Modern Automatic Heat Co., Poughkeepsie, N. Y.

DAVIDSON, J. C., Jr. Htg. & Air Cond. Engr., Dept. of Bldgs., Minneapolis, Minn. (*Advancement*)

GRITSCHKE, E. R., Cons. Engr., Chicago, Ill.

HESSELSCHWERDT, A. L., JR., Instructor, Wayne Univ., Detroit, Mich. (*Advancement*)

INMAN, MACON, Supervising Engr., Cafritz Co., Washington, D. C.

MALIN, B. S., Mech. Inspector, U. S. Dept. of Agriculture, Peoria, Ill. (*Advancement*)

MCENTEE, F. M., Air Con. Engr., Archt. of the Capitol, Washington, D. C.

PETERSON, D. J., Dist. Mgr., Minneapolis-Honeywell Reg. Co., Buffalo, N. Y.

PRAWL, F. E., Cons. Engr., Prawl Engrg. Co., Scottsbluff, Nebr. (*Advancement*)

ASSOCIATES

BABER, J. E., Sales Engr., T. C. Heyward, Charlotte, N. C.

BRUNNER, E. G., Burner Sales, Dome Oil Co., Inc., Washington, D. C.

DERER, BERNARD, Pres., Airo Contracting Co., Inc., Brooklyn, N. Y.

DABBS, J. T., Chief Engr., Highland Technical School, Los Angeles, Calif.

HACKETT, F. C., Sales Repr., Bell & Gossett Co., Arlington, Va.

HORNE, H. F., Sales Engr., Johns-Manville Co., Washington, D. C.

JENKINSON, V. J., Sales Engr., Minneapolis-Honeywell Reg. Co., Ltd., Toronto, Ont., Can.

KELLY, J. J., Sales Engr., Philadelphia Elec. & Mfg. Co., Philadelphia, Pa.

LEY, R. B., Mgr. Cooling Div., United Equip. & Supply Co., Washington, D. C.

LUDLOW, H. M., Sales & Engrg., Jackson, Miss.

LYNCH, J. R., Owner, Lynch Furnace Co., Portland, Ore.

PARKINSON, J. S., Acoustical Engr., Johns-Manville Research Labs., Manville, N. J.

SMITH, R. C., Engr., York Ice Machinery Corp., St. Louis, Mo.

STOTT, D. A., Mgr., Canadian Powers Reg. Co., Ltd., Toronto, Ont., Can.

STRAND, C. A., Supt., Bruce Wigle Co., Detroit, Mich.

WOOTEN, M. F., Jr., Cons. Engr., Charlotte, N. C.

JUNIORS

ARMOUR, E. G., Sales Engr., Armour's Plbg., Htg., Elec. Contractors, Brantford, Ont., Can. (*Advancement*)

CROLEY, J. G., Htg. Engr., Savannah Gas Co., Savannah, Ga.

CUMMINGS, R. J., Engr. & Estimator, Franck & Fric, Cleveland, Ohio

DOUGLAS, D. C., Tech. Sales Engr., United Equip. & Supply Co., Washington, D. C.

GRAVES, F. V., Engr. & Sales, Frank A. Leon Co., Washington, D. C.

GRAY, W. C., Air Cond. & Htg. Engr., Gulf, Mobile & Northern R. R. Co., Bogalusa, La.

JORDY, J. J., Engr. & Contractor, Jordy Bros., Inc., New Orleans, La.

KOENIG, A. C., Sales Engr., Evansville, Ind.

STUDENTS

BREYER, FREDERICK, Student, Carnegie Inst. of Tech., Pittsburgh, Pa.

CLEMENS, J. D., Grad. Student, Purdue Univ., West Lafayette, Ind.

EKLUND, G. P., Student, Univ. of Minnesota, Minneapolis, Minn.

ELY, R. S., Student, Mich. State College, East Lansing, Mich.

FOOTE, J. H., Jr., Student, Mich. State College, East Lansing, Mich.

HERRE, H. A., Student, Carnegie Inst. of Tech., Pittsburgh, Pa.

JONES, H. S., Student, Carnegie Inst. of Tech., Pittsburgh, Pa.

KELLY, O. A., Student, Mich. State College, East Lansing, Mich.

LIEBLICH, MURRAY, Student, Carnegie Inst. of Tech., Pittsburgh, Pa.

MERZ, R. A., Student, Mich. State College, East Lansing, Mich.

OBERLIN, J. A., Student, Mich. State College, East Lansing, Mich.

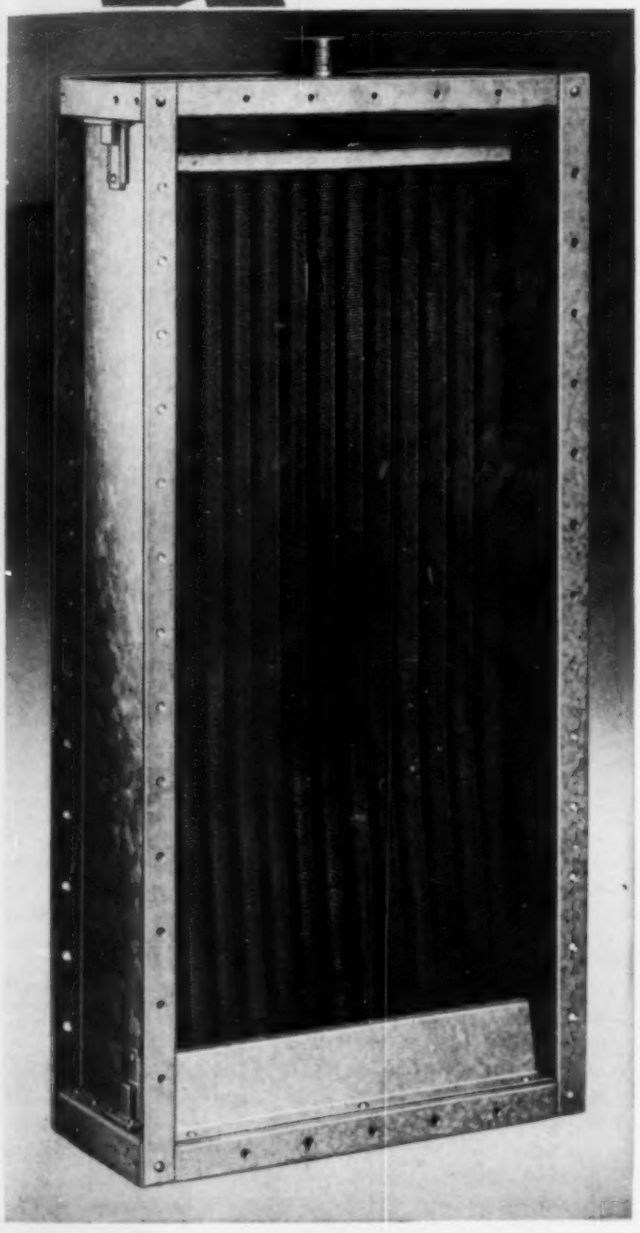
PAETZ, G. A., Student, Purdue Univ., West Lafayette, Ind.

TILLINGHAST, H. S., Estimator, Minneapolis Gas Light Co., Minneapolis, Minn.

WARREN, H. P., Lab. Asst., Texas Engrg. Exp. Sta., College Station, Tex.

WINER, B. B., Student, Carnegie Inst. of Tech., Pittsburgh, Pa.

44 YEARS HEAT TRANSFER EXPERIENCE



stand behind fedders Type K HEATING COILS and the men who install and use them

44

Time is a good measure of experience! It teaches what NOT to do as well as what to do. Fedders Type K Heating Coil design is the cumulative result of 44 years of specialized experience in heat transfer,—theoretically, practically, reliably, and economically.

Copper fins bonded to copper tubes . . . patented, full-floating relief of expansion stresses between heating coil and casing . . . "knee-action" relief of differential expansion between neighboring tubes . . . heavy, forged bronze expansion guides . . . large plenum-type steam headers . . . integral orifices and scale breakers,—those are some of the advanced engineering features of Fedders Type K Heating Coils.

In addition,—husky, rigid ARMCO ZINCGRIP casings provide adequate protection against piping stresses and coil distortion.

Complete data is given in new Catalog AC-601. It is a time-saving, working tool for heating men who want to save hours in engineering. Write for your copy right now.

FEDDERS COOLING COILS

New Complete Range of Sizes for Refrigerants and Cold Water.

FEDDERS UNIT AIR CONDITIONERS

Seven Base Models from 1½ to 25 Tons Capacity.

FEDDERS SERIES 4 UNIT HEATERS

Full Range of Models from 75 to 1100 EDR.

FEDDERS MANUFACTURING CO.,
Air Conditioning Division; 81 Tonawanda St., Buffalo, N. Y.

Please send my personal copy of
- ☐ Type K Heating Coil Catalog AC-601.
- ☐ Type R & W Cooling Coil Catalog 392.
- ☐ Unit Air Conditioner Catalog AC-202.
- ☐ Unit Heater Catalog 578.

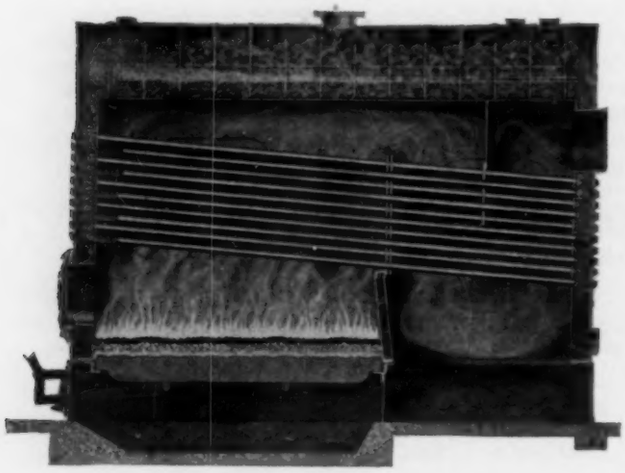
Name .....
Concern .....
Street .....
City .....

Apply the same rules to your heating boiler specifications as used by large power plant engineers where pinch-penny economy is always demanded—specify STEEL WATER TUBE BOILERS.

Built for modern heating and modern firing International "FUELSAVER" STEEL WATER TUBE BOILERS are known for their complete absorption of gases—lowest stack temperature. The rapid, constant circulation; quick pick up; and high overload capacity assure the residence, large building, or plant the same economy and performance demanded in power plants where every penny counts. And we might add "FUEL SAVER" Boilers are practically self cleaning.

Send for Catalog H — see us in Sweet's

THE INTERNATIONAL BOILER WORKS CO.
11 BIRCH ST., EAST STROUDSBURG, PA.
Established 1886



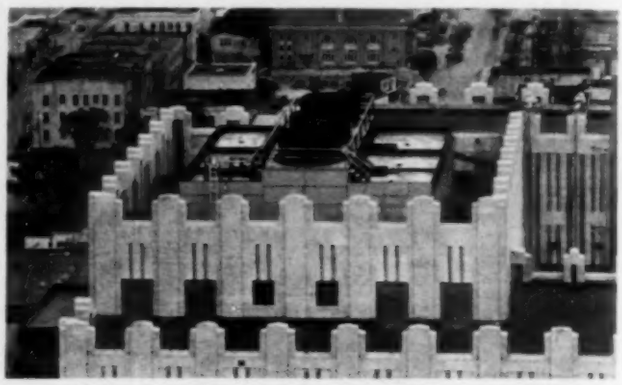
"FUEL SAVER"
WATER TUBE
STEEL HEATING & POWER BOILERS

Equipment Developments

For your convenience in obtaining more information about any of this equipment, see coupon on page 142. Add the new products and companies listed here to your Directory Section which you received in your January, 1940, HEATING, PIPING AND AIR CONDITIONING and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed

New Type of Cooling Tower

No. 1833—After two years of testing and proving, a new type of cooling tower ("Double-Flow") of patented design especially developed for heavy duty, large capacity service has been announced. High efficiency and low operating costs are its features, the manufacturer states. The tower's unique design, an advancement from the induced draft type, is such to prevent recirculation of hot saturated used air, it is stated. Mixture of water with moving air is uniform throughout the interior area, and air flow is without turbulence since it is horizontal from both sides to the center chamber from whence the top fans expel it.



Operating savings are attributed to reduction in pumping costs due to low height and a distribution system which requires no pressure. Other advantages are freedom from "icing-up" in winter, a water distribution system that is entirely external to simplify inspection and maintenance, and all bolted, diagonally braced construction.

Sizes of existing installations range from single fan units of 2000 gpm to one tower having twelve 13 ft fans and another with fourteen fans under construction.—Marley Co., 3001 Fairfax Rd., Kansas City, Kans.

Capacitor Motors for Air Conditioning

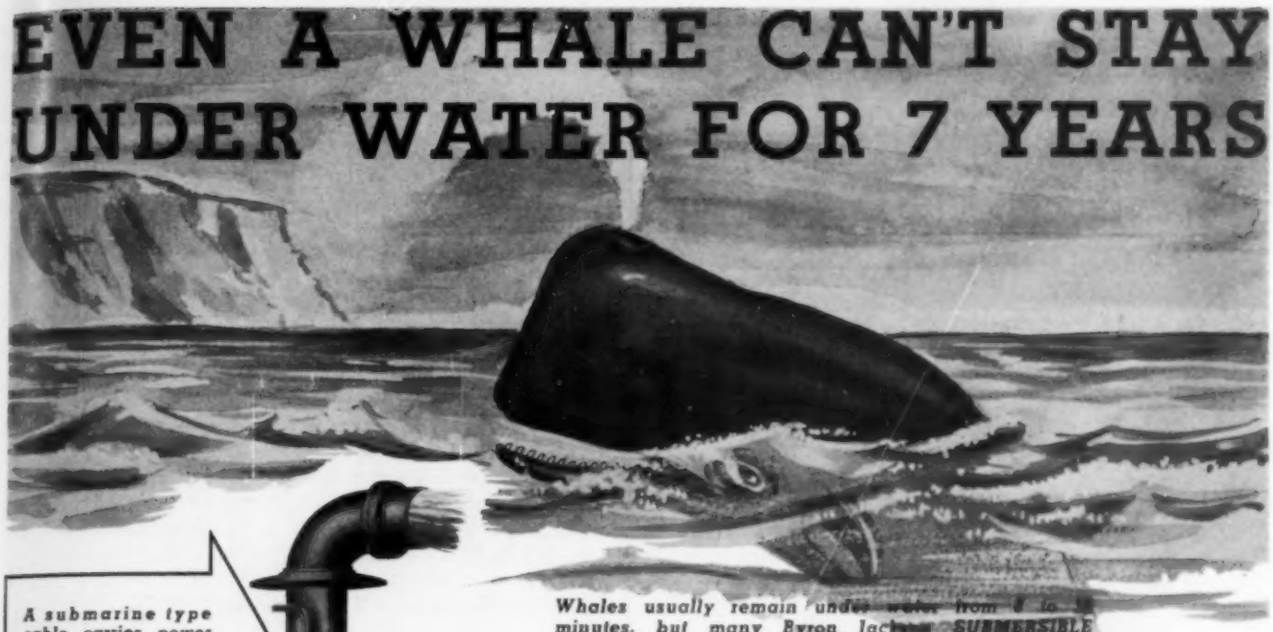
No. 1834—Extension of a line of capacitor motors for refrigeration and air conditioning service, which previously included ratings from ⅛ to ¾ hp, now makes them available to 3 hp, inclusive.

Fundamentally, a capacitor motor is a single phase motor that obtains starting and pull-up torques by the use of two stator windings and a capacitor. It consists of but five electrical parts; a cast aluminum rotor, a starting winding and a running winding, a centrifugally operated switch, and a capacitor. The starting and running characteristics of such motors are well suited to air conditioning and refrigeration service, the maker states. They develop the high starting torque required for these applications, and have a high efficiency.—General Electric Co., 1 River Rd., Schenectady, N. Y.

New Machine Vibration Isolator

No. 1835—A new vibration isolator, designed to control machine vibration and reduce the resulting noise, is known as the

EVEN A WHALE CAN'T STAY UNDER WATER FOR 7 YEARS



Whales usually remain under water from 5 to 30 minutes, but many Byron Jackson SUBMERSIBLE Pumps have been submerged for more than 7 years!

A submarine type cable carries power to submerged motor.
ANY DESIRED LENGTH
Pumping unit of BYRON JACKSON, high efficiency design.
Any number of stages can be furnished, depending on well depth.
Mercury seal keeps water from active parts of motor.
Motor enclosed in case is kept cool by water being pumped.
Motor submerged in well, safe from heat, thieves or tampering.

THIS SUCCESSFUL PUMP is practically "made to order" for industrial and commercial air conditioning installations and merits your detailed investigation. The SUBMERSIBLE consists of an electric motor (enclosed in a steel case filled with dielectric oil) mounted below and direct-connected to an efficient deepwell pump. The SUBMERSIBLE eliminates the long shaft and many bearings, which cause unnecessary trouble, down-time and expense—particularly in crooked wells.

The SUBMERSIBLE unit—motor and pump—is attached to the lower end of the discharge pipe, and operates at all times completely submerged in the water being pumped. A minimum of floor space is required, and the switchbox can be mounted on a wall for manual or automatic operation, ideal for remote control. Power is conducted down the well to the motor through a submarine type cable, and the submerged motor and pump operate free from noise or vibration.

Every air conditioning engineer or contractor is invited to send for the descriptve brochure which contains a 44" long cross section of the SUBMERSIBLE, printed in 4 colors. It is free upon request, and you will not be obligated in any manner—write for it now!

BYRON JACKSON CO.

Dept. CS-11
Executive Offices and Factory: 2150 East Slauson Avenue
(Mail Address, Box 2017, Terminal Annex) LOS ANGELES, CALIFORNIA
Factories: Foot of Carlton Street, BERKELEY, CALIFORNIA
P. O. Box 409, BETHLEHEM, PENNSYLVANIA
6247 Navigation Blvd. (Mail Address Drawer 2198) HOUSTON, TEXAS
Sales Offices: 407 South Dearborn Street, Chicago, Illinois
420 Lexington Avenue, New York, N. Y.

BYRON JACKSON

SUBMERSIBLE

Kleenflo
AIR FILTER PANELS FOR
AIR CONDITIONING AND
VENTILATING SYSTEMS

LINT

IS NO PROBLEM WITH
THIS FILTER PANEL

● Lint, always present in considerable quantities in the air of homes and many business establishments, usually presents a serious problem for conventional types of air filters. Unless the filter panel is properly constructed lint will soon clog it to the point where efficiency of the air conditioning unit is seriously impaired.

The scientific construction of AIR-MAZE *Kleenflo* air filter panels, with their unique series of screens embodying exactly graduated density, is especially effective against lint. Heavier lint is caught on the face of the deeply crimped outer screen where it can be easily brushed off because of the smooth round wires to which lint cannot hold fast. There's no clogging to obstruct free flow of air because even fine lint is no "bugaboo" for *Kleenflo* panels.

Lint can be easily brushed off the AIR-MAZE Kleenflo Filter Panel.

Because they are so efficient and because they need no replacement AIR-MAZE *Kleenflo* filter panels are economical. Easily cleaned at a cost of only a few cents. All-metal construction—odorless—sturdy and easy to handle as they slip readily into existing panel spaces. *Approved by the Underwriters Laboratories as fire retardant.* Write for detailed information.

AIR-MAZE CORPORATION
5200 HARVARD AVE., CLEVELAND, OHIO

AIR-MAZE

"J-M Controlled Spring Isolator." It was developed for use on the bases of motors, generators, pumps, ventilating fans, and similar equipment where vibration and excessive motion create noise and tend to wear out machine parts and damage connections as well as crack supporting walls and floors.

The working parts of the unit consist of a coil spring and a rubber load pad, which support the equipment and isolate vibration, and an adjustable rubber snubber inside the base, which controls excessive motion. Through the combination of these parts, the manufacturer states, the isolator provides both the high compliance necessary for good isolation and the control needed to limit motion in the equipment. The isolator was built to take care of horizontal and torsional as well as vertical vibration, and tests by the maker indicate it to be efficient for the low frequency vibrations resulting from slow speeds and from many operations involving reciprocal action. The load pad is designed to overcome any high frequency vibrations.

The isolator is made in two sizes, light duty for loads from 60 to 190 lb per isolator, and heavy duty for loads from 250 to 720 lb per isolator. Heavy machines may be isolated by clusters of the units. The loaded overall dimensions of the isolator are 6 in. x 6 in. by approximately 3¾ in. high. It is enclosed in a metal jacket to protect the rubber parts from oil and light.—Johns-Manville, 22 E. 40th St., New York, N. Y.

Straight Line Exhauster

No. 1836—For handling air containing steam, dirt, fumes, paint, spray, grease, vapors, etc., a new straight line exhauster has been developed as a companion to the maker's elbow type exhauster. It is available in horizontal or vertical designs with belt drive to permit selection of any fan speed to fit various conditions of air volume and resistance.

This exhauster is equipped with a "Scruplex" propeller fan for delivering large air volumes against duct or wind resistance. The motor is outside the air duct to keep it clean and cool and to reduce fire hazards when the air mixtures being exhausted are inflammable or explosive.—L. J. Wing Mfg. Co., 14th St. & 7th Ave., New York, N. Y.

New Copper Perfected

No. 1837—Announcement of a new type of copper developed after a 10 year research program has been made. It is known as "PDCP," and great conducting power, ductility, fatigue resistance and surface quality are its characteristics, according to the manufacturer.

This metal is made without melting from electrolytic cathode copper, which is plastically converted by high pressure in a reducing atmosphere at elevated temperature into smooth, dense copper bar, rod, strip or other desired commercial shapes. Basically of the oxygen free type, the intrinsic purity of electrolytic cathode copper is retained and enhanced at the high temperature of the reducing gas used in the process, it is announced.

Applications of this metal include high frequency and high voltage transformer windings, and it is especially adapted to high tension and submarine cables, refrigeration and air conditioning installations, the maker says; it is particularly applicable for service where severe vibration is a problem.—Phelps Dodge Copper Products Corp., 40 Wall St., New York, N. Y.

Mechanical Ring Balance Meter

No. 1838—A new mechanical meter of the ring balance type for metering steam, water, gas, air, etc., at static pressures up to 1000 lb per sq in. was announced last month.

ABP Always
meant a lot . . .
NOW ABP MEANS MORE
THAN EVER BEFORE . . .
The improved emblem of The Associated Business Papers is symbolic of its greater significance to advertisers. Its Standards of Practice, guide-posts of ethical business paper publishing for twenty-three years, have this year been made stronger and more enforceable than ever before. Apace with the times, its member publications are constantly making their editorial pages more dynamic . . . increasing their hold on their reader-audiences. Singly in relation to your markets, and collectively as an association, these modernized A·B·P-A·B·C publications deliver an abundance of what it takes to produce resultful advertising.

TIME CARDS
Show the Savings on
SIMPLIFIED PIPING

● Savings realized on simplified piping with Anderson Super-Silvertops are clearly shown by the installation time cards. You actually save from 30 to 60 minutes of installation time on every steam trap installed in addition to the cost of the fittings. That's how simplified piping saves on steam trap costs.

But that is only one of the advantages of Anderson Super-Silvertop steam traps. Their increased capacity usually permits a smaller, less expensive trap in the first place. Also, clean-cut, simplified piping makes a neater, better looking piping job (compare the difference in the illustrations). Furthermore, users say that Anderson Super-Silvertops stay on the line—they eliminate constant repairs and maintenance. That is because the valve and seat are built to last (replaced free of charge if valve leaks within one year), and the bucket doesn't scrape or batter itself against the side walls of the body. Besides, large drilled passages do not clog with dirt and scale, hence these engineered steam traps do not need frequent cleaning.

Find out more about this steam trap that stays on the line—the trap that saves installation time—write for complete details and prices.

THE V. D. ANDERSON CO.
1949 West 96th Street • Cleveland, Ohio

Super-Silvertop STEAM TRAPS

This meter will give full scale readings on differentials as low as 3 in of water—ideal for low pressure gas and air measurement, according to its maker. The meter is housed in a steel case suitable for exposed locations, and is adjusted by changing a calibrating weight. It has a 12 in. evenly graduated chart and is furnished with any combination of indicator, recorder and cyclometer type integrator.—Republic Flow Meters Co., 2240 Diversey Pkwy., Chicago, Ill.

Solenoid Valve for Conditioning Control

No. 1839—A new solenoid valve particularly adapted to the requirements of the heating and air conditioning industry as well as to general applications in the control of air, oil, water, and gas was recently introduced. It may be used as a water control for humidifiers, as an oil shutoff for oil burner service, pilot gas control for gas burners, air control for compressed air devices, or for evaporative cooling equipment, the maker states.

Since it is designed to be incorporated into an assembly that has its own enclosure, no coil cover, conduit plate, etc., have been provided.—General Electric Co., 1 River Rd., Schenectady, N. Y.

Power Roof Ventilator

No. 1840—A new power roof ventilator offers a large volume of air per horsepower while maintaining low tip speeds, according to the manufacturer, who states that this makes possible quiet operation and high efficiency. Special aerodynamical design of the fan blades assures uniform velocity of air over the working face of the fan.

Non-overloading power characteristics protect against burned out motors. Entrance eddy losses are reduced by a new patented "Log Cone" entrance ring to allow free entrance of air to the fan blades.

These roof ventilators are available in a wide range of sizes and capacities.—DeBothezat Ventilating Equipment Div., American Machine & Metals, Inc., East Moline, Ill.

Flange Head Oil Immersion Heater

No. 1841—A special flange head oil immersion heater for particular use in high pressure systems has heater tubes of steel silver soldered into a cast iron head. The units are made for both circulating and non-circulating systems.

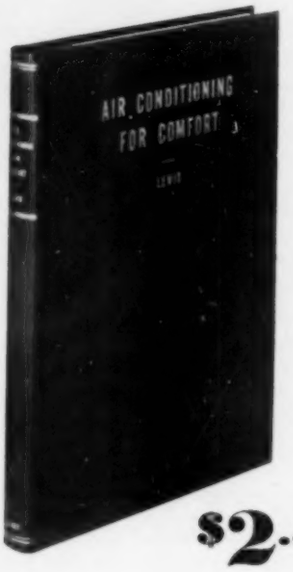
The non-circulating heaters have a rating of from 1 to 3 kw for 115 or 230 volts with two heater tubes ranging in length from 14⅞ to 37⅞ in. The circulating heaters have either two or four heater tubes from 33⅜ to 37⅞ in. long with a rating of from 5 to 8 kw for 230 volts.—Westinghouse Electric & Mfg. Co., Mansfield, Ohio.

Aluminum Alloy Wall Fans

No. 1842**—Two series of new wall fans of aluminum alloy construction, ranging in diameters from 12 to 36 in. and 42 to 48 in. and employing four and six blade propellers, respectively, have been announced. Motors range from 1/40 to 7½ hp, with a maximum capacity of 40,000 cfm of air. When desired, these fans can be supplied with guard and automatic shutters. The frame and the propeller blades are both made of high tensile aluminum alloy, and each is cast in one piece.

The units may be had for any available current, the maker

IMPROVE YOUR KNOWLEDGE OF AIR CONDITIONING



$2.50

SEND TODAY FOR
The Third Edition
of Samuel R. Lewis'

"AIR CONDITIONING FOR COMFORT"

288 Pages—6¼" x 9¼"—Illustrated—
Cloth Bound—$2.50

Here is a book that presents—in simple, readily understandable form—every kind of information necessary for an accurate and thorough knowledge of air conditioning principles, equipment, and practices. Written by S. R. Lewis, a widely-known consulting engineer who has been active in air conditioning work for more than thirty years, it deals with all angles of the air conditioning subject from the practicing engineer's viewpoint. The designing procedures explained in the book are, for example, in every detail the same procedures employed today by the author's own organization.

Featuring this third edition are several entirely new chapters on phases of the subject not previously treated, including noise control, air conditioning measurements, air conditioning standards, fire protection codes and operating suggestions. Brand new designing examples are also used, together with new forms for recording the design data, the proper filling-in of which is explained step-by-step.

The chapter devoted to Psychrometry presents nineteen different formulas for psychrometric calculations. In illustrating the correct use of these formulas, Mr. Lewis applies both the psychrometric tables and chart in order to render both devices thoroughly understandable. The chart used in this edition is less complex than the one used in his previous book.

OF VALUE BOTH AS A REFERENCE AND TEXT

Engineers in air conditioning will find the new "Air Conditioning for Comfort" invaluable as a reference book, while salesmen, students, and others may rely on it to give them a clear knowledge of fundamentals, and of the latest air conditioning methods and equipment.

Send for a copy today. We know you will consider this volume the most readable and complete book on the air conditioning science you have yet seen. You will risk nothing in ordering a copy, for you will be privileged to return it for a refund if for any reason it should prove unsatisfactory. Use the coupon at the left to order your copy now.

KEENEY PUBLISHING COMPANY
6 N. Michigan Ave. Chicago, Ill.

CONTENTS

CHAP. 1—Terms Used in Air Conditioning
CHAP. 2—Heat and Air
CHAP. 3—Air Conditioning Standards
CHAP. 4—Air Conditioning and the Human Body
CHAP. 5—The Psychrometric Table and Chart
CHAP. 6—Humidity Controllers and Control
CHAP. 7—Heat Transmission Through Barriers
CHAP. 8—Ventilation, Solar and Appliance Heat
CHAP. 9—Heating Systems
CHAP. 10—Air Conditioning Systems
CHAP. 11—Air Conditioning Apparatus
CHAP. 12—Refrigeration and Refrigerants
CHAP. 13—Refrigeration Compressors and Condensers
CHAP. 14—Refrigeration Evaporators and Auxiliaries
CHAP. 15—Record Forms for Heating and Cooling
CHAP. 16—Air Distribution
CHAP. 17—Water in Air Conditioning
CHAP. 18—Noise and Its Control
CHAP. 19—Air Conditioning Instruments and Measurements
CHAP. 20—Codes and Operating Suggestions
10" x 16" Psychrometric Chart..Inside Back Cover

KEENEY PUBLISHING COMPANY
6 N. Michigan Ave., Chicago, Ill.

Enclosed is $2.50 for a copy of the new AIR CONDITIONING FOR COMFORT. If this book should prove unsatisfactory, I will return it within 15 days for a refund.

NAME .....

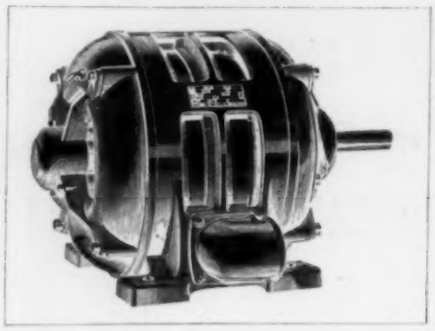
STREET .....

CITY & STATE .....

states. Motors are available for single and variable speeds, and may have horizontal or vertical mountings, the latter requiring ball bearing motors. Speeds of the larger fans range from 340 to 860 rpm and the smaller ones from 715 to 1750 rpm.—Truflo Fan Co., 523 Main St., Harmony, Pa.

Motor for Air Conditioning

No. 1843—The new "Lo-Amp" electric motor has been especially designed for use on refrigerating, air conditioning and similar installations. This motor has low locked rotor current and can be supplied with either high starting torque or normal starting torque, the maker states.



The motor has the rugged simplicity of a standard squirrel cage motor, and does not have any centrifugal switches, relays, brushes or slip rings. It does not require special control to operate.—Louis Allis Co., 427 E. Stewart St., Milwaukee, Wis.

Corrosion Resistant Spray Nozzles

No. 1844—A new line of corrosion resistant "Whirljet" nonclogging spray nozzles is available in brass, all iron, hardened steel, stainless steel, Monel metal, lead, hard rubber and other materials. They are offered for various industrial and chemical process uses as well as air conditioning.

The pipe connection is ⅜ in. male, and capacities range from 0.5 to 2.5 gpm at 10 lb pressure. The nozzles produce a hollow cone spray with uniform distribution, according to the maker.—Spraying Systems Co., 4021 W. Lake St., Chicago, Ill.

Ozone Generator

No. 1845*—An ozone generating unit to be used in conjunction with electric fans, known as the "Ozonator," is a small cylindrical unit which produces its effect by an electrical discharge. The device is 6 in. long by 3¼ in. in diameter, weighs 3½ lb and is furnished with an adjustable clamp so it may be attached to the upright member of a circulator fan or fastened to a wall. The metal housing is chromium plated, and a 10 ft rubber-covered cord is supplied, ready to be plugged into any standard 110 volt a-c circuit.

Current consumption is less than 10 watts, and capacity is 40 cubic centimeters of ozone per hour, according to the maker. The device is particularly adapted to use with large circulating fans, air conditioning units, blowers, and any type of equipment which permits the ozone to be drawn into the air stream and thoroughly diffused throughout the area treated. This allows time for oxidation of odors and impurities and ensures no spots where the air has an unduly heavy charge, according to the maker.—Russell Electric Co., 348 W. Huron St., Chicago, Ill.

Tool for Replacing Gaskets in Pipe Lines

No. 1846—A new tool designed specifically to simplify the job of opening flanges on existing pipe lines for the renewal of gaskets has been announced. Known as "Flange-Jacks," they come in pairs and in three sizes, the "Midget" for pipe under 2 in., the "Standard" for standard flanges 2 in. to 20 in. and extra heavy flanges up to 12 in., and the "Giant" for standard flanges

▶ *Why You Should Use* ◀

RIC-WIL Insulated Pipe Units

STABILITY
STRENGTH
SIMPLICITY
REAL PIPE SUPPORT AND GUIDE SCREW INTO CONDUIT — REMOVABLE
PIPE AND ITS COVERING FREE FROM ANY LOAD ON THE CONDUIT
HEAVY ASPHALT SHELL IS OUTSIDE OF AND SUPPORTED BY STRONG ARMCO CONDUIT
COUPLER POSITIVELY SLIP-SEALED NO GUESSWORK INVOLVED
CROSS SECTION
DURABLE
WATERTIGHT
ENGINEERING
RIC-WIL INSULATED PIPE UNITS

- The Pre-sealed Unit for high efficiency.
- Structural strength of Armco Hel-Cor Conduit + Ric-wiL engineering throughout.
- Choice of grade and type of insulation—either bulk hand-packed or sectional pipe covering.
- A complete ready-assembled unit—nothing else to buy.

Write for Bulletin No. 4003

THE RIC-WIL COMPANY
Union Commerce Building
CLEVELAND, OHIO
New York Chicago San Francisco

Agents in Principal Cities

For Underground or Outside Overhead Steam Lines

14 in. to 48 in. and extra heavy flanges 10 in. to 30 in. According to the manufacturer, with the use of these tools joints are opened quickly even when working space is cramped or limited, and flange faces will not be damaged.

To use these tools, two bolts are removed from the flanges at 180 deg from each other and the jaws of one jack are placed in each of the bolt holes, the screws being tightened up just enough to hold the jacks in position. The remainder of the bolts are then removed from the joint and the jackscrews are tightened to separate the flanges evenly. When sufficient opening between the flanges has been obtained, the old gasket is removed, the flange faces are cleaned and the new gasket is inserted. The jackscrews are then backed off simultaneously. the jacks are removed and the flange bolts are applied.—Garlock Packing Co., 50 Main St., Palmyra, N. Y.

Large Size Explosion Proof Motors

No. 1847—In the Class I, Group D explosion proof motors of one manufacturer, approved by the National Board of Fire Underwriters, the ratings have been increased from 25 to 75 hp; in Class II, Group G they have been increased from 7½ to 75 hp.

The larger motors are of the shell type frame construction and have a specially designed fan which is said by the maker to be quiet even at high speeds. Wiring is convenient with a large terminal box.

The fan-end inner end bell and the outer fan cover bracket are held in place with a simplified type combination screw. This construction elimmates one set of holding screws and supplies rigid and secure mounting for the fan cover and bracket as well as facilitating the assembly or disassembly of the motor.—U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles, Calif.

Industrial Finish

No. 1848—A new industrial finish for metal surfaces, called "No. 1 Chromelume," a ready mixed aluminum, has been announced. According to the manufacturer, its features are: (1) an extreme brilliance, (2) will air dry in 15 min, (3) will not rub off after aging, (4) covers approximately 2000 sq ft of surface per gal, (5) will not settle or pack in container, (6) can be dipped, sprayed, or flow coated, (7) retains its elasticity, and (8) keeps its luster and will not powder.—Tousey Varnish Co., 520 W. 25th St., Chicago, Ill.

Three New Room Coolers

No. 1849—Emphasis on modern styling, more cooling per kwhr of input, and reductions in physical size feature three new room coolers (one window type and two consoles), according to the manufacturer. The ½ hp window type has a net cooling capacity of 5000 Btu per hr and is 28 in. wide, 19 in. high and projects into the room 9 in. from the window sill. The ½ hp console model is rated at 6000 Btu per hr net cooling, while the ¾ hp model has a net cooling capacity of 8000 Btu. Both consoles measure approximately 35 in. high and extend 19 in. from the wall.

Ventilation control is the important engineering feature of the consoles. The turn of a dial changes the damper arrangement to supply the room with 100 per cent outside air, if desired, or with 10 per cent outside and 90 per cent recirculated air.

A TEN STRIKE!

THE Tuttle & Bailey Aerofuse Outlet, combining unsurpassed efficiency in the distribution of conditioned air, and unobtrusive beauty, has fast won the enthusiastic endorsement of architects, engineers and contractors. Designed to provide 1. Maximum Air Mixture, 2. Rapid Temperature Equalization, 3. Perfect Air Distribution, 4. Total Elimination of Drafts; this outlet is practically flush with the ceiling line. Combines tastefully with lighting fixtures if desired. Brochure No. 40 fully details and describes the Aerofuse Outlet and the Aerofuse Supply and Return Unit.

AEROFUSE OUTLET

FUNCTIONAL SUPERIORITY + UNOBTRUSIVE BEAUTY

T & B TUTTLE & BAILEY, Inc.

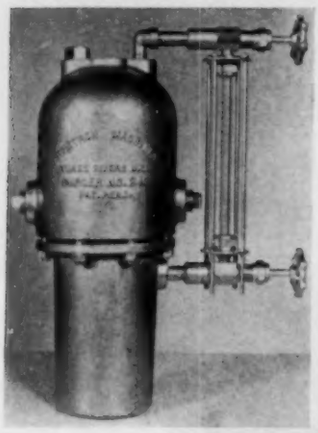
NEW BRITAIN, CONN

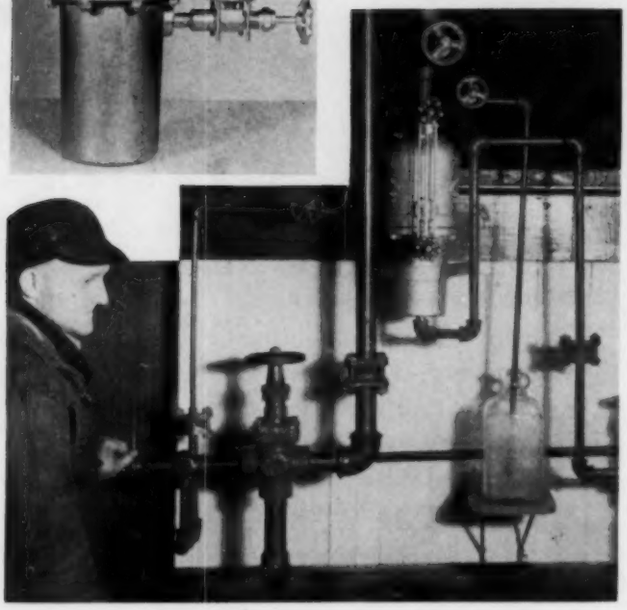
NEW YORK CHICAGO PHILADELPHIA

NEW!

THE ARMSTRONG PURGER

for removing air from refrigerating systems





IF it is part of your job to specify . . . operate . . . or install compression type refrigerating equipment, it will be well worth your while to find out about the new Armstrong Purger for removing air and other non-condensible gases from refrigeration systems. Following are a few quick facts:

1 CUTS POWER COST. Records show reductions in head pressure of as much as 45 lbs. and power savings as high as 22% where units are installed.

2 INCREASES COMPRESSOR CAPACITY. Every 4 lbs. reduction in head pressure increases compressor capacity approximately 1%.

3 SAVES REFRIGERANT GAS. As compared with wasteful blow-down methods of purging, this new unit reduces loss to a negligible amount.

4 LOW COST. The list price is only $100.00 for a unit that is being used successfully on systems ranging from 12 tons up to 1200 ton capacity.

Write for complete information. New bulletin just off the press. ARMSTRONG MACHINE WORKS, 874 Maple St., Three Rivers, Mich.

The ARMSTRONG PURGER

Pilot lights indicate when the fans and compressor are running; and switches marked "Fan," "Cool," and "Fresh Air" control the various functions of the unit. There is a place for a built-in thermostat and a time switch is available as optional equipment. Maximum air flow for the larger unit is 280 cfm, while the smaller handles 200 cfm. Louvers at the discharge grilles can be adjusted to direct the flow of air. All air entering the room, whether recirculated or from outside, passes through filters of viscous coated glass wool, and a copper screen is provided for insect protection. Ducts for exhaust and outside air end at the window sash, so that the window can be opened and closed.

The window model is simply "plugged in" a light socket to operate. The motor, compressor and condenser fan are housed in the portion of the unit which is outside the window, and acoustical treatment of air passages also contributes to quietness. —General Electric Co., Air Conditioning and Commercial Refrigeration Dept., 5 Lawrence St., Bloomfield, N. J.

Diminutive Ball Bearings

No. 1850—It was announced last month that a line of diminutive size precision ball bearings—down to ⅛ in. bore—which have heretofore been available in the "full" (retainerless) type, can now be obtained as standard with retainers (or ball cages). The dimensions of these bearings are as follows:

Bearing No.	Bore	OD	Width
N-463-R	⅛ in.	⅜ in.	5/32 in.
4666-R	1/16 in.	½ in.	5/32 in.
XA-134-R	¼ in.	⅝ in.	0.196 in.
XA-134-R-P	¼ in.	⅝ in.	0.196 in.
XA-134-R-PP	¼ in.	⅝ in.	0.196 in.

The XA-134-R-P is available with single side plate and the XA-134-R-PP with two side plates.—Norma-Hoffmann Bearings Corp., Stamford, Conn.

Low Melting Alloy

No. 1851—"Powder-Braze" is a powdered low melting alloy compressed to ring or washer shapes and offered for brazing copper tubing to headers in unit heaters and in air conditioning apparatus. According to the manufacturer, this alloy melts at approximately 1350 F and in the preformed shape helps to speed up the brazing operations—especially where a salt bath is utilized for the brazing operation.

This alloy is available in the powder form, the ring or washer form, and also in strips of any desired width and thickness from 0.010 in.—Charles Hardy, Inc., 415 Lexington Ave., New York, N. Y.

Propeller Type Agitators

No. 1852—A complete line of propeller type air motor drive agitators for both open and closed containers has been announced. The agitator for open containers consists of two airplane type propellers, one pitched right and the other pitched left, so that they throw toward each other to insure perfect mixture and prevent splashing. The closed container agitators comprise a drive for closed barrels which have their own agitating mechanism.

The shafts for the open container types can be furnished from 12 in. to 27 in. long, and the adjustable clamps enable the operator to fasten the agitator to the outside of the barrel in any desired position.—Binks Mfg. Co., 3114-40 Carroll Ave., Chicago, Ill.

Automatic High Speed Whiteprint Machine

No. 1853—The "Model A" automatic high speed whiteprint machine employs a new quartz envelope high pressure mercury vapor lamp to provide a fast printing speed (ranging up to 20 fpm), and assure uniform distribution over the entire printing surface. The lamp is guaranteed by the maker for 1000 hrs, and was designed especially for this service.

The machine is available in two sizes for production of prints up to and including 42 and 54 in. widths. An ingenious device

CURTIS REFRIGERATION
AIR CONDITIONING AND COMMERCIAL

Packaged Air Conditioning

Meets Your Customer's Demands!

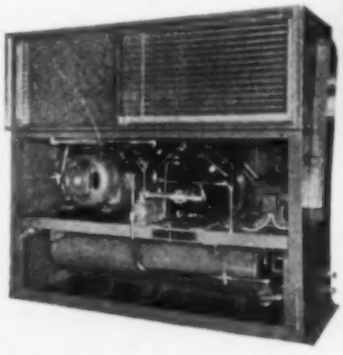
THE Curtis line of packaged air conditioners meets the growing demand of all classes of retail establishments for effective, efficient cooling—yet these units eliminate costly installation expense.

You can sell this rapidly expanding market that includes retail stores, offices, restaurants, banks, beauty parlors, etc., with Curtis packaged air conditioning units that require only water and electrical connections to install.

There's a wide range of capacities, from 3 to 15 tons. Both the Curtis Store and Office Cooler and the Curtis Remote or Central Type Air Conditioner are complete factory designed, packaged air conditioning units that mechanically cool, dehumidify, circulate and filter the air. They are quickly and easily installed without disturbing store fixtures and are adaptable for heating if desired.

The packaged air conditioning market is a fast growing source of sales and profits. Write for complete information on the Curtis line.

CURTIS REFRIGERATING MACHINE COMPANY
Division of Curtis Manufacturing Co.
1950 Kienlen Avenue St. Louis, Missouri



7½—10—15 Ton Complete Remote or Central Type Air Conditioner

3 and 5 ton Packaged Type Air Conditioner

● The Curtis line of Condensing Units includes sizes from 1-6 to 30 h.p., air and water cooled. There's a Curtis model for every refrigerating or air conditioning requirement, each precision engineered to deliver economical, trouble-free performance throughout an exceptionally long life.

EHRET'S DURANT INSULATED PIPE

. . . FOR UNDERGROUND AND WEATHER-EXPOSED STEAM LINES

When insulated piping is to be enclosed in a protective system, the insulating material used should be efficient and long-lived. That is why D.I.P. is built with Ehret's 85% Magnesia. Regardless of the passing of the years, 85% Magnesia maintains its high initial insulating efficiency. Being a molded material, it can not shift, pack, settle or disintegrate. It is the ideal insulation for use in underground steam service.

The new Ehret Durant Insulated Pipe Booklet, as shown at the left, will be sent on request.

EHRET MAGNESIA MANUFACTURING COMPANY
VALLEY FORGE PENNSYLVANIA

MAKERS OF INDUSTRIAL INSULATIONS FOR MORE THAN 40 YEARS

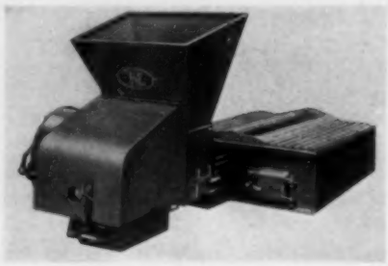
automatically separates the print from the original after exposure. The original is returned to the operator in front of the machine, while the exposed print is automatically conveyed to the developing unit, where, after dry development, it is discharged at the rear of the machine ready for immediate use.

A variable transformer in the primary circuit permits a variation of intensity of the high pressure mercury vapor lamp from full brilliancy to 60 per cent of light without energy loss. This dimming arrangement allows the operator to select the desired intensity, and permits continuous and uniform production of prints, despite variations in tracings.

The high pressure mercury vapor lamp is cooled by an alternating air blast, which passes through the space between the revolving contact cylinder and the fixed cylinder surrounding the quartz envelope high pressure mercury vapor lamp. By alternating the cooling air stream, high temperatures between the left and right sides of the contact cylinders are avoided.—Ozalid Corp., Ansco Rd., Johnson City, N. Y.

Small Commercial Stoker

No. 1854—The recently announced "F & E Series 40" underfeed stoker was designed primarily for heating boilers rated between 25 and 100 hp and is adaptable to either bituminous or anthracite coal. It is a ram feed stoker powered by a unit type electro-hydraulic drive which has but three moving parts.



Features include synchronized coal feed and air control designed to insure proper "carburetion" at all rates, a full length, sliding bottom retort, and a fuel bed regulator for outside regulation while the fire is burning. The mechanism and the ram are protected from damage by foreign matter in the coal by a ram safety device, and there is a removable ram case liner. The anthracite model incorporates specially designed tuyere grates, either of stationary or moving design and continuous ash discharge.

A bin feed device can be furnished with these stokers.—Flynn & Emrich Co., 301 Holliday St., Baltimore, Md.

Cold Water Cooling Coils

No. 1855—Two new lines of cold water cooling coils, a cleanable type and a continuous tube type, have been announced. The former is for use where cooling water conditions are such that cleaning of the tubes will be necessary, and the latter is for use where there is no possibility of deposition of silt or film on the inside of the tubes to restrict water flow.

The HESS PNEUMATIC CONDENSER for REFRIGERATION and AIR CONDITIONING Gets a Big Hand

★ **Operates on an improved evaporative principle**
★ **These condensers are real water savers**
★ **Suitable for Freon, Ammonia, and other refrigerants**

Available in 15 standard sizes up to 100 tons capacity. Larger capacities also furnished.
Sold through sales engineering representatives in principal cities.
Made by a responsible company with 67 years of experience.

Write for catalog or send us your condensing problem

HESS WARMING AND VENTILATING CO.
Established 1873
1211-27 S. WESTERN AVE.
CHICAGO, ILL.

They're Both "Buffalo" PUMPS!

More and more consulting engineers and contractors are finding that the best way to solve all of their pumping problems both large and small is to bring them to Buffalo Pumps, Inc.

Here they are able to find the *right* answer for every pumping service in any capacity, for any head, for any liquid.

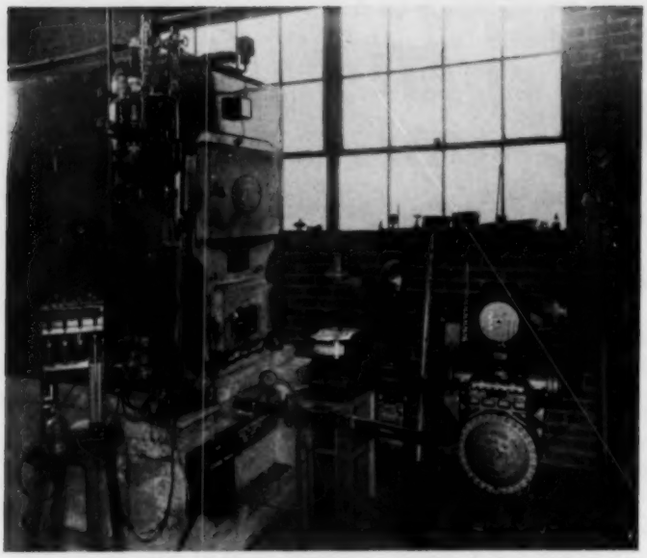
Time is money. You can save both by taking advantage of this comprehensive pump service.

BUFFALO PUMPS, INC.

171 Mortimer St. **Buffalo, N. Y.**

Canada Pumps, Ltd., Kitchener, Ont.

PROVING GROUND



Showing test boiler, and part of laboratory equipment.

Problems of burner design and operation are solved in our own plant. Constant laboratory experimentation, with burners under actual load conditions, enables Webster to offer constant improvement in burner design and operation. Webster Burners are tested and ready to go.

Every Webster Burner is Engineered, Manufactured, Tested, and Serviced by ONE organization.

A burner for every combustion problem.

THE WEBSTER ENGINEERING CO., TULSA, OKLA.

Division of — **SURFACE COMBUSTION CORP., TOLEDO, OHIO**

YOUNG *Streamaire*

In addition to being modern and pleasing in design as well as dependable in operation, Young STREAMAIRE convectors are thoroughly tested in accordance with the American Society of Heating and Ventilating Engineers' Code and are available in many sizes, types and heating capacities.

Whether you are equipping a new building or modernizing an old one, be sure to select Young STREAMAIRE convectors and assure the utmost satisfaction to the building owner, manager and tenants.

Offices in all Principal Cities

COPPER CONVECTORS

SEND FOR THIS NEW CATALOG

A new, fully illustrated 24 page catalog attractively printed in colors, showing interesting installations and mechanical details —giving capacities and complete performance tables—and containing recommended piping diagrams, will be sent upon receipt of the coupon below. This catalog presents the complete story of Young STREAMAIRE convectors—the modern way to comfortable heating.

---------CLIP THIS COUPON---------

Please send your NEW CATALOG illustrating Young STREAMAIRE Copper Convectors.

COMPANY .....

ADDRESS .....

SIGNATURE .....

YOUNG RADIATOR COMPANY

RACINE, WISCONSIN

Young Quality

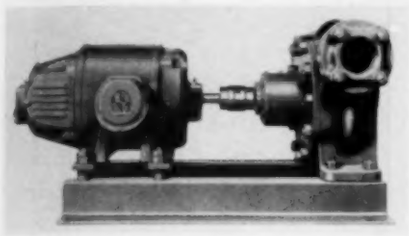
Features incorporated in these coils include flow mixers in each tube to promote turbulence and thus reduce necessity for high water velocities, built-in provisions for water counterflow to simplify external piping connections, and adaptability for use for heating as well as cooling. The cleanable type is guaranteed to withstand water temperatures of 200 F and the continuous type temperatures of 250 F.

On the cleanable type the entire header can be removed by taking off a few hexagonal nuts, the flow mixers withdrawn and a wire brush inserted for cleaning.

These coils are available in three widths and 13 lengths ranging from 2 ft 8½ in. to 10 ft 8½ in., and two depths, four rows and six rows of tubes.—Modine Mfg. Co., 17th St., Racine, Wis.

High Capacity Hot Water Heating Pumps

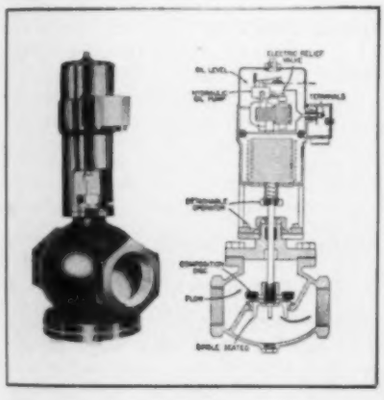
No. 1856—Two new high capacity units added to the manufacturer's line of circulating pumps enlarge the field for forced hot water heating. They are the "B & G" belt driven pump, for head pressures up to 25 ft, and the universal type pump, capable of handling head pressures up to 90 ft.



The universal type pump comes in a wide range of capacities and the belt driven pump is available in two capacities, with ½ and ¾ hp motors respectively. Both belt driven units have 3 in. connections.—Bell & Gossett Co., 3000 Wallace St., Chicago, Ill.

Hydraulically Operated Motor Valve

No. 1857—Announcement was recently made of the "Hydramotor" valve, an all-purpose hydraulically operated motor valve for handling air, gas, water, oil, brine, saturated steam, etc. It is of the full ported, single seated type and affords tight shut-off in any position, according to the maker. The electric pilot valve has a two wire current failure control, with low current consumption.



The valve itself is normally closed; applying current opens it. Approximate opening time is 45 sec; approximate closing time, 10 sec.

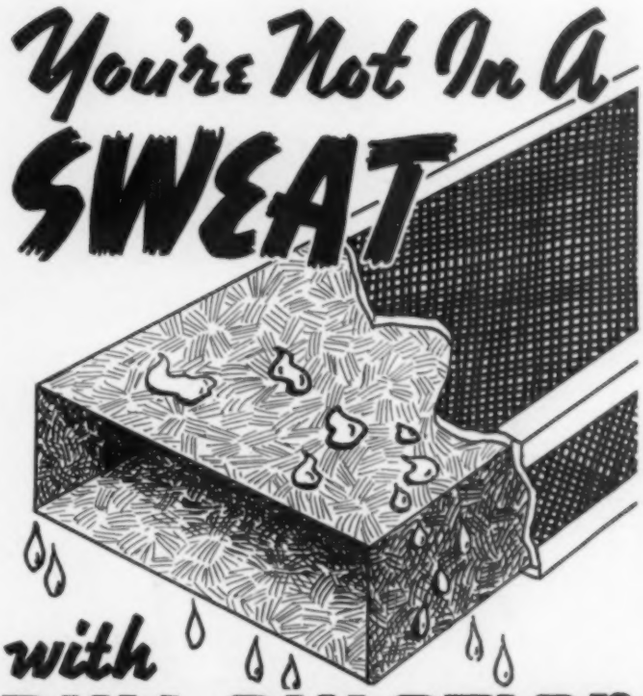
Composition discs are furnished to suit the service. Style "F" disc is for air, brine, butane and natural gas, light oils and water of temperatures not exceeding 125 F. Style "H" disc is for steam to 150 lb and temperature not exceeding 400 F. Style "L" disc is for hot water to 250 lb and temperature not exceeding 250 F, and for steam up to 25 lb.

These valves are regularly furnished in IPS valve sizes of ½ to 1½ in. with brass body, bronze trim, and 2 to 4 in. with iron body, bronze trim. The 4 in. size has flange connections optional.—General Controls Co., 700 W. Ivy St., Glendale, Calif.

Small Steel Valves

No. 1858—A new line of small steel valves for steam and oil services includes gates, globes, angles and checks, in sizes ¼

You're Not In A SWEAT



with DUX-SULATION

AIR CONDITIONING DUCTS DON'T SWEAT WHEN COVERED WITH DUX-SULATION

Comes in a Roll, 100 square feet 36" wide, complete with accessories for easy applying.

NO MORE DRIPPY DUCTS.
SANITARY AND CLEAN FLOORS.
NO MORE RUSTY DUCTS.
PERMANENT INSULATION.
NO MORE SPOILED GOODS.
EASY TO APPLY.
NO MORE SPOILED DECORATIONS.
ATTRACTIVE APPEARANCE.
NO TEMPERATURE LOSSES.
GREATER OPERATING ECONOMY.
NO PAINTING NECESSARY.
QUIETS MECHANICAL NOISES.
ASBESTOS PROTECTION.

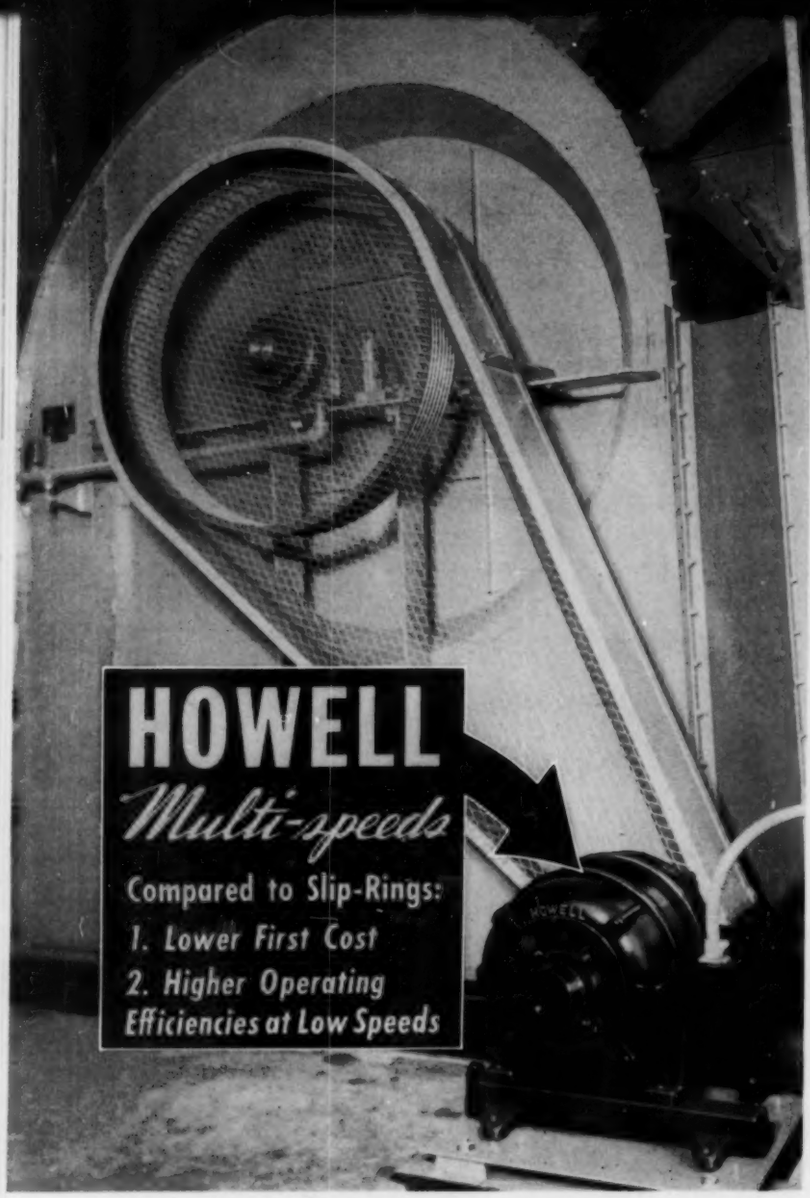
Write! Let us tell you more

GRANT WILSON, INC.
4101 West Taylor Street CHICAGO

PLANT RUBBER & ASBESTOS WORKS
537 Brannan Street SAN FRANCISCO

AIR CONDITIONING UTILITIES CO.
8 West 40th Street NEW YORK

ATLAS ASBESTOS CO., LTD.
110 McGill St. MONTREAL, CANADA



Use These 2, 3 and 4-Speed Motors for ECONOMY on Variable Speed Drives . . .

Year after year more engineers and contractors specify and use HOWELL Multi-Speed Motors — for driving fans, pumps, compressors, etc. They find that these 2, 3 or 4-speed motors meet a great many requirements without any sacrifice of results — *and the savings*, as against expensive slip-ring motors with expensive variable speed control, *are considerable.*

A pioneer in multi-speed motor development, HOWELL has a wealth of knowledge and experience *from which you can profit.* Wherever more than one operating speed is necessary, consult with us!

FAST DELIVERY ON ANY DESIRED QUANTITY

IMMEDIATE ENGINEERING SERVICE

★ ***Multi-speed motor shown above drives fan in air conditioning system — large pharmaceutical plant. This company (name upon request) INSISTS on HOWELL, as a result of over 20 years' experience with hundreds of HOWELL Motors of all types.***

YOUR NEEDS - STANDARD OR SPECIAL?

HOWELL makes all types of air-conditioning motors, ½ to 150 HP — a goodly share of them SPECIAL motors. If you have ANY drive problem, and want FAST ACTION, direct your inquiry our way. Even though special, we can produce your job immediately—NO DELAY. *At HOWELL, real service and finest quality go hand in hand.*

1915 · 1940 HOWELL MOTORS 25th Anniversary Year

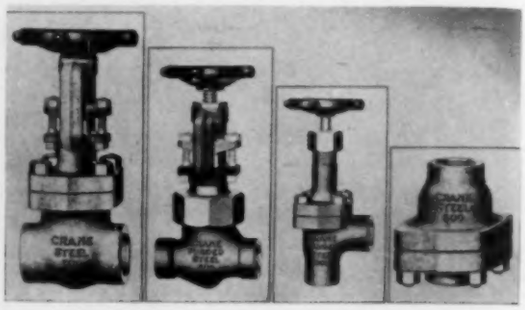
HOWELL ELECTRIC MOTORS COMPANY
HOWELL, MICHIGAN
Representatives In All Principal Cities

to 2 in., inclusive, and embodies both inside screw and OS & Y construction, union and bolted bonnets, screwed, socket weld, and flanged ends. In all, there are 176 valves of the types mentioned. The line includes:

Gate valves made of cast steel with O S & Y construction having union bonnet type in screwed ends in sizes ¼ to ¾ in., and bolted bonnet with screwed, socket weld, and flanged ends in sizes ½ to 2 in. (½ and ¾ in. are available in both union and bolted bonnet).

Globe and angle valves made of forged steel in two types, inside screw and O S & Y construction. Inside screw valves have screwed ends with union bonnet in sizes ¼ to ¾ in. and bolted bonnet in sizes 1 to 2 in. O S & Y valves have screwed ends with union bonnet in sizes ¼ to ¾ in., and screwed, socket weld, and flanged ends with bolted bonnet in sizes ½ to 2 in. (½ and ¾ in. are available in both union and bolted bonnet).

Check valves also made in two types. The horizontal pattern is forged steel with union cap and screwed ends in sizes ¼ to ¾ in., and with bolted cap and screwed, socket weld, and flanged ends in sizes ½ to 2 in. (½ and ¾ in. are available in both union and bolted cap). The vertical ball pattern is cast steel with bolted joint and screwed ends in sizes ½ to 2 in.



The castings for the gate valves and the vertical ball pattern check valves represent an innovation in steel foundry practice in the valve and fitting industry, according to the manufacturer. Carefully compounded from selected raw materials, this steel is melted by high frequency induction methods with exacting control of composition and temperature. The result is "Radio-cast" steel, so-called because of the development and control of foundry technique and periodic x-ray and gamma ray radiographic inspection of castings.—Crane Co., 836 S. Michigan Ave., Chicago, Ill.

Across the Line Motor Starter

No. 1859—Improvements in an across the line starter for the control and protection of polyphase squirrel cage motors up to 5 hp include the following, according to the manufacturer:

Streamlined, simplified, hook-on cover, held by one fastening screw, can be removed for easy installation. Permits group panel mounting with minimum clearance between adjacent starters. Interior finished in light aluminum to facilitate wiring and inspection in poorly illuminated locations.

Loosening one screw permits removal of operating mechanism for wiring and conduit work.

Contacts made of heavier "fine" silver. Lava insulators protect contact springs against heat transmission to insure full contact pressure at all times. For protection against rust, contact springs and contact supports are made of stainless steel; all other metal parts are cadmium plated.

The "Drop of Solder" overload relay has been made smaller in size, more accessible, with better operating characteristics. Overload trip indication is a further improvement.

This starter is available in the following types of cover control: reset only for two or three wire remote control; start and stop reset buttons for three wire control; and three position selector switch for manual-off-automatic local control or two or three wire remote control. NEMA type enclosures include general purpose, water tight, dust tight, and Class I-D or II-G. The starter can be obtained in open panel type for cavity or built-in mounting.—Cutler-Hammer, Inc., N. 12th St. and W. St. Paul Ave., Milwaukee, Wis.

Duct and Insertion Thermometers

No. 1860—Designed especially for air conditioning applications, the new "W59A" thermometer incorporates a remote bulb with a mounting clip to permit mounting the operating element

The Enduring Metal-

FOR ALL AIR CONDITIONING JOBS

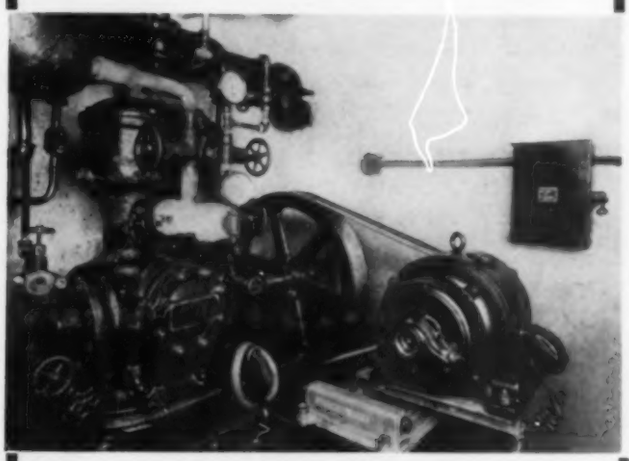
HUSSEY

PURE LAKE COPPER

Thousands of years ago Indians found solid deposits of pure copper in the Great Lakes regions and beat it into many useful forms. Since unearthed, these ancient forms reveal the remarkable immunity of Nature's own copper to corrosion. Because Hussey Pure Lake Copper comes from the same pure Great Lake deposits, the working and corrosion-resisting qualities of Hussey are unique—one of the big reasons why Hussey Copper is so widely preferred in the air conditioning industry today. You will find it remarkably easy to work, shape and bend. Try Hussey on your next job.

C. G. HUSSEY & CO.
(DIVISION OF COPPER RANGE CO.)
Rolling Mills and General Offices: PITTSBURGH, PA.
Warehouses in Principal Cities

FORMER RECORD! WORE OUT 11 BELTS IN 13 MONTHS ON THEIR REFRIGERATION SYSTEM DRIVE « « «



» » » REPLACED WITH TANNATE-ROCKWOOD DRIVE! ON SAME JOB 8 YEARS « « « STILL GIVING FINE SERVICE

Says the owner of this drive: *"It is so quiet I don't know when it is running . . . Getting more refrigeration than I ever had before . . . Haven't had the least bit of trouble with it. If I couldn't get another TANNATE-Rockwood unit to take its place, I wouldn't sell this one for twice what I paid for it!"*

There is your answer (from actual experience) to your question of what drive does best on installations of this character.

Our engineering advice is yours without obligation. For further information write—

J. E. RHOADS & SONS
Established 1702
35 N. Sixth St., Philadelphia, Pa.
New York Chicago Atlanta Cleveland
Factory and Tannery—Wilmington, Del.

Representatives In All Principal Cities

Five WAYS TO CUT DRAFTING TIME and EXPENSE

● Here's how OZALID TRANSPARENT papers, cloths, and foils provide short cuts in drafting practice and reduce costs.

1. DUPLICATE ORIGINALS ON TRANSPARENT PAPER, CLOTH OR FOIL FOR BRANCHES OR CUSTOMERS . . . made in the same simple manner as standard Ozalid Whiteprints.

2. TRANSPARENT DUPLICATES WITH CHANGES FOR SPECIAL PURPOSES WITHOUT ALTERING ORIGINAL DRAWING . . . produced by deleting detail and making additions on the duplicate. Standard Ozalid Whiteprints incorporating these changes are made from these transparent duplicates.

3. OLD, SOILED OR WORN TRACINGS...reclaimed and weak pencil lines intensified with Ozalid foil which can be cleaned to eliminate spots, blotches and crease marks.

4. COMPOSITE PRINTS . . . accomplished by bringing the details of as many as six originals together into one Ozalid Whiteprint by the use of Ozalid foil.

5. WHITEPRINTS . . . made from inexpensive Ozalid transparent duplicates, while valuable originals are stored safe from fire, wear, and tear.

ONLY OZALID HAS DRY DEVELOPMENT

Ozalid CORPORATION
ANSCO ROAD · JOHNSON CITY, NEW YORK

OZALID CORPORATION 22—5
Ansco Road, Johnson City, N. Y.
Please send full information on how Ozalid transparent materials cut drafting costs, and free booklet of dry-developed Ozalid prints.
Name_____
Company_____
Street_____
City_____ State_____

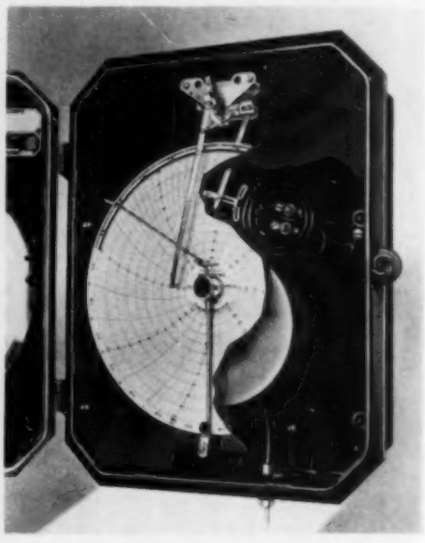
where it will measure the temperature at the desired point within the duct. A universal mounting bracket allows the face of the thermometer to point to the right, left or straight ahead, and also to point at any angle between vertical and horizontal. This feature, combined with the wide red liquid column, permits temperature readings from a distance of several feet, the maker states.

Another similar model, the "W59B," is also available. It does not have a flexible element; instead it has a protecting well and is intended for insertion in water pipes or tanks. Both models have a standard range of —30 to +180 F.

These thermometers are finished in polished aluminum. Height is 9 in., the scale length itself being 6½ in.—Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave., S., Minneapolis, Minn.

New Line of Recorders

No. 1861—To provide companion recording instruments for the redesigned line of "Fulscope" controllers, the manufacturer has announced new recorders for temperature, humidity, pressure, load, rate of flow, liquid level, and receivers for pneumatic transmission systems. Exclusive of the controller mechanism, the recorders and recording controllers are identical. The cases are drilled and tapped to receive any of the five standard control mechanisms should it be desirable to add it at a later date.



The universal case is for both face and flush mounting. The time required for changing charts is reduced by a mechanism that combines the chart locking device and pen lifter. A die-cast aluminum chart plate gives a rigid surface for pencil notations on the chart and for carrying the chart clamp and pen lifter.

These recorders are available with 10 or 12 in. charts, and with one, two or three pens.—Taylor Instrument Companies, 95 Ames St., Rochester, N. Y.

Control Relay

No. 1862—A new relay for controlling a stoker in conjunction with time switch, limit controls, and room thermostat can also be used as a relay for blower motors of unit heaters controlled from room thermostat, as a relay between room thermostat and condensing unit in central plant cooling systems, and as a relay between humidistat and humidification systems.

This single pole relay combines in one assembly the relay itself, a low voltage control transformer, and terminal board. Six terminals on a convenient terminal block provide means for line, load, and limit control connections, without the use of a connection box. There are three conduit openings for interconnecting with other control devices.—General Electric Co., 1 River Rd., Schenectady, N. Y.

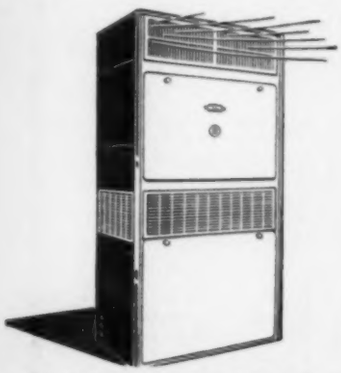
Ceiling Type Air Distributing Device

No. 1863**—A new ceiling type air distributing device has recently been announced which—according to the manufacturer—offers the following features: draftless diffusion, low resistance,

Get Literature now on FRICK

Unit Air Conditioners

And see why they are preferred by restaurants, stores, beauty parlors, offices, etc., everywhere.



Frick Unit Air Conditioner

Frick Unit Air Conditioners have extra capacity because each is equipped with water-cooled motor and machine space. Large slow-speed refrigerating machine is quieter, more dependable. Built in 3 and 5 hp. sizes.

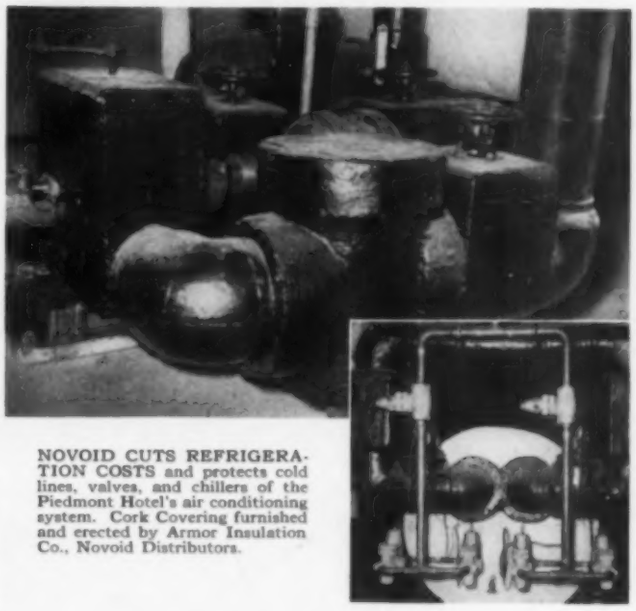
Give your business the benefit of air conditioning: write for Bulletin 520 today.

FRICK CO. WAYNESBORO, PENNA. U.S.A.

DEPENDABLE REFRIGERATION SINCE 1882

HOW *Novoid* AIDS AIR CONDITIONING

in Atlanta's Famous Piedmont H



NOVOID CUTS REFRIGERATION COSTS and protects cold lines, valves, and chillers of the Piedmont Hotel's air conditioning system. Cork Covering furnished and erected by Armor Insulation Co., Novoid Distributors.

LONG FAMOUS for its southern hospitality, Atlanta's Piedmont Hotel is now famous for air conditioned comfort. And that comfort is supplied *efficiently* and *economically* through cold lines and risers lastingly insulated with NOVOID CORK COVERING.

This natural CORK material has proved its worth time and time again in all kinds of air conditioning installations. It effectively bars the passage of heat, prevents destructive condensation, and aids in temperature control. Properly installed, Novoid Cork Covering provides years of trouble-free, money-saving service.

Novoid Cork Covering is light in weight, yet strong and rigid. It is specially fabricated in shapes and thicknesses to fit any piping arrangement . . . for every temperature need. Find out more about this efficient, lasting Cork insulation. Mail the handy coupon below for complete details. Address Cork Import Corp., 330 West 42nd Street, New York City.

NOVOID CORK INSULATION

MAIL COUPON FOR FULL DETAILS

Cork Import Corporation, HPA-5
330 West 42nd Street, New York City

Please send me complete information about Novoid Cork Covering for all air conditioning pipe lines.

Name .....

Street ..... City and State .....

Eliminate BY-PASSING AND RE-HEATING WITH

KATHABAR

PRE-CREATED HUMIDITY

You don't need to be told how it will simplify your problem to *start with air of the desired humidity.* All you have to do is to engineer temperature treatment and circulation.

Kathabar creates—rather than controls—humidity. Regardless of outside conditions, Kathabar delivers both the humidity and temperature you want with unvarying uniformity, summer or winter, rain or shine, by the simple action of separate valves.

Kathabar Pre-created Humidity is available to all refrigeration, heating and ventilating contractors and air-conditioning equipment manufacturers. The Kathabar unit fits readily into all specifications. We will gladly send you complete information.

SURFACE COMBUSTION CORPORATION · TOLEDO, OHIO

WHAT IS KATHABAR?

Kathabar applies the unique qualities of a chemical called Kathene, the vapor pressure or humidity of which easily can be changed at will. Air coming in contact with Kathene automatically tends to the vapor pressure of the Kathene, thus creating in treated air any desired humidity with absolute precision regardless of weather. Kathene also cleans and deodorizes the air and renders common air borne bacteria inert. Kathene is non-inflammable, non-explosive, odorless and inherently harmless. The Kathabar unit is compact, readily accommodated in practically any space and controlled by the simple action of a single valve.

- **FOR COMFORT**—in hotels, restaurants, public buildings, office buildings, factories, stores, theatres and recreation places.
- **FOR HEALTHFUL COMFORT**—in hospitals and institutions.
- **FOR CONTROLLED DRYING**—in factories where materials and their by-products must be dried under controlled conditions.
- **FOR SPECIAL ATMOSPHERES**—in industries where air conditions affect materials, processes and products.
- **FOR DRY BLAST**—in cupola and blast furnaces where conditioned air is required in combustion.

FOR 34 YEARS THE LARGEST MANUFACTURERS OF GAS-FIRED EQUIPMENT EXCLUSIVELY

SURFACE COMBUSTION

ALSO MANUFACTURERS OF SC INDUSTRIAL FURNACES AND JANITROL GAS-FIRED DOMESTIC AND COMMERCIAL HEATING EQUIPMENT

Hank tells about Burnham Heatin' Contrapshuns going to Santiago, Chile

SEZ I to myself, Santiago, Chile, is a long-fur-way-off ter ship heatin' contrapshuns.

Then I sez to myself some more, and it sounded somethin' like this: Sez I, when the smartest engineers in an important big South American city like Santiago, sends way fur up here ter get 420 Burnham Radiators, 4 Unit Air Conditioners, and a passel of our Unit Heaters, it ain't exactly because other kinds is better than Burnham's.

Furthermore (which in this case is further even than just more) when yer come to think, as how the hull transaction wuz done by mail, it's sure putting a lot of trust in the Lord and our Burnham folks.

Course, South America ain't exactly strangers to Burnham products. Still it is a fur ways off. So it must be as how Burnham's reputation is as long as 'tis frum here to there, or we'd never a got ter first base on heatin' that big Santiago hospital, let alone even getting a crack at the ball.

A reputation, like rubbers or an umbrella, is a kinda handy thing to have around. Getting wet is easier than keeping dry. We see to it Burnham's reputation don't even so much as get even damp. Which is sumpthin worth your remembering not ter furgit.

Hank Hindle

BURNHAM BOILER CORPORATION

Distributed Through Wholesalers

Irvington, N. Y., Dept. P Zanesville, O., Dept. P

Branch Offices In All Principal Cities

Export Dept.: 50 Church St., New York City

Burnham Boiler

and equalization of temperatures within the occupied zone.

Known as "Kno-Draft," it is designed to handle large volumes of air without noise, to premix room air and supply air, and to permit use of high duct velocities. It is available in 12 sizes.—Plandaire, Inc., 207 Fulton Bldg., Pittsburgh, Pa.

Diaphragm Packless Valves

No. 1864—A new line of diaphragm packless valves incorporating a "balancing action" designed to assure positive valve opening under all pressure conditions has been announced. Pressures above and below the seat are equalized at the instant of opening, which allows the use of a lighter spring and assures positive opening at all times, according to the maker.

Other features include handwheels of oval shape to afford a natural gripping surface, and inlet and outlet ports directly in line to simplify installation. The valves are made in all standard types, two way, three way, and angle, in the following size range: Flare fittings, ¼ to ⅝ in., solder connections, ¼ OD to 1⅛ in. OD, male pipe thread, ¼ to 1 in.—Henry Valve Co., 1019 N. Spaulding Ave., Chicago, Ill.

Air Diffusers

No. 1865**—A new line of "Agitair" air diffusers has recently been announced and is available in two types, the "Type C" and the "Type R." The "Type C" is available with a built-in lighting unit which is shallow and is equipped with either of two types of light diffusing bowls, one for use as a flush mounted unit, and the other for surface mounting. Fluorescent lighting units in the form of an outer ring surrounding the air diffuser can be supplied on special order and offer opportunities for decorative lighting effects.

The "Type R" diffuser may be adjusted for one, two, three or four way diffusion and, according to the manufacturer, it need not be located centrally. It can be supplied in a pattern to fit the space served, the maker states, and offers high velocity discharge, high aspiration and turbulence within the primary air stream.—Air Devices, Inc., 17 E. 42nd St., New York, N. Y.

Portable Scotch Marine Boiler

No. 1866—The new "Scottie Junior" is a small portable return tubular Scotch marine type boiler for high pressure steam and is available in five sizes, 9.9 to 30 hp, 1400 to 4200 sq ft radiation, 100 lb working pressure. It is offered particularly for use in dry cleaner and pressing establishments, laundries, creameries, dairies, cheese factories, etc.

No brick-up work is required and precast refractory insulating blocks are fitted in place at the factory. The boilers are shipped with complete set-up accessories, may be mounted on wood skids and need no foundation settings.—Kewanee Boiler Corp., Kewanee, Ill.

Remote Control for Arc Welders

No. 1867—A new device for remote control of the manufacturer's "Hornet" arc welders has been announced. To utilize the new device, the handwheel which governs the control pole of the standard welder is replaced by the reversible motor driven remote control. It allows minute adjustments in current output by touching one of two contacts on the electrode holder to the ground. In other words, when the electrode holder button marked "more" is brought into contact with the ground, the electric motor in the remote control housing on top of the machine revolves and raises the control pole core, increasing the output. The motor revolves only while actual contact is maintained. When the button marked "less" is grounded, the remote control motor revolves in the opposite direction and lowers the control pole core, decreasing the output.—Wilson Welder & Metals Co., Inc., 60 E. 42nd St., New York, N. Y.

Suffolk County Courthouse, Boston, Mass., **recently built by George A. Fuller Co., General Contractors, Desmond & Lord, Architects. To keep ducts permanently quiet and fire-safe, Engineers of the J. C. Higgins and R. D. Kimball Co. used more than 18,000 feet of J-M Airacoustic Sheets as linings.**

AIR-CONDITIONING DUCTS LINED WITH AIRACOUSTIC SHEETS

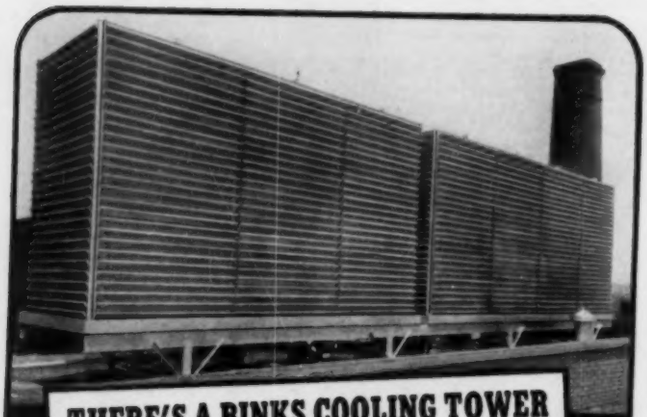
THERE'S no noise nuisance . . . no fire hazard . . . in the air-conditioning ducts of the Suffolk County Courthouse, Boston, Mass. Engineers of J. C. Higgins & R. D. Kimball Co. used a simple, inexpensive method of eliminating such troubles. They lined all ducts in the system with J-M Airacoustic Sheets.

This modern lining offers every feature necessary for comfort, firesafety and economy. It keeps ducts quiet by soaking up more than 70% of noise in the system. Basically mineral, it will not flame . . . introduces no fire hazard. Furthermore, Airacoustic Sheets are strong, durable, highly moisture-resistant. And they cost so little you can easily include their extra protection in every estimate.

Let the facts show how you can give your clients quieter air-conditioning systems with J-M Airacoustic Sheets. For details write Johns-Manville, 22 East 40th Street, New York, N. Y.

Light in Weight and Easy To Handl
J-M Airacoustic Sheets are installe quickly, easily, at low cost. Furthermor their mineral base cannot contribute the spread of fire. And their unusu moisture resistance prevents damage b humidity.

Johns-Manville
AIRACOUSTIC SHEETS FOR DUCT LININGS



THERE'S A BINKS COOLING TOWER FOR EVERY WATER-COOLING JOB

Whether your problem is cooling the water for a small air conditioning unit or a large installation serving a complete building, BINKS has just the right cooling tower. Each is custom built to meet your specific needs. There is no waste. The use of BINKS famous spray nozzles in these towers further increases their efficiency. All types of towers are available—atmospheric, induced and forced draft.

SEND TODAY for BINKS' complete water cooling catalog and data book

BINKS MANUFACTURING COMPANY
3114-40 CARROLL AVE. Dept. H540 CHICAGO, ILLINOIS

ELECTRIC HEAT advantageous and economical in sterilizing oven

A capacity of 10.8 Kw. provides the temperature of 230 deg. F. required to sterilize the textile product this oven handles. Twelve Chromalox strip heaters with thermostat regulation serve the need.

CHROMALOX
ELECTRIC STRIP HEATERS

suitably mounted, make it easy to build a most efficient industrial oven. Sheet metal construction with required insulating material, and a bank of strip heaters in the base, will provide dry, safe, economical, and accurately controlled heat. Chromalox units are most successful in numbers of these applications.

If you wish to consider electric heat, use the cooperation of Wiegand engineers in developing details of application, performance, and costs. No obligation. Chromalox catalog mailed at your request.

EDWIN L. WIEGAND COMPANY
7610 Thomas Blvd. Pittsburgh, Pa.

Mercury Clutch

No. 1868**—A new mercury clutch permits a driving motor to gain speed before assuming load. Utilizing mercury to displace friction segments by centrifugal force, the clutch gradually picks up the load at full speed; thus smaller motors may be used when starting under load, according to the manufacturer. At present, 4 and 4½ in. diameter sizes are standard, and will transmit loads up to 5 hp. Other sizes are available on specification.

Four principal parts comprise the clutch: the driving member or housing, the driven member or inner drum, the clutch segments and the mercury, the latter being introduced or removed through filler holes. In operation, mercury displaces the clutch segments inward, where they engage the drum at the proper time and speed, a positive drive being effected when the speed of the housing and driven drum are synchronized. It is possible to predetermine the time or speed of engagement.

Overloads and other shocks are not transmitted through the clutch to the prime mover, the maker states, the capacity of the clutch limiting the torque transmitted. The unit operates in a vertical or horizontal position.—Mercury Clutch Corp., 637 W. 3rd St., Massillon, Ohio.

Conventions and Expositions

Anthracite Conference: May 9-10, Packard Auditorium, Lehigh University, Bethlehem, Pa. Program includes papers on research and radiant heating.

Building Industry Week: May 13-18, Chicago, Ill. Paul D. Angell, Secretary, Chicago Building Congress, 29 S. La Salle St.

National District Heating Association: Annual meeting, May 14-17, French Lick Springs Hotel, French Lick, Ind. Secretary-treasurer, John F. Collins, Jr., 1231 Grant Bldg., Pittsburgh, Pa.

Smoke Prevention Association: Annual convention, May 21-24, Hotel Statler, St. Louis, Mo. Headquarters office, City Hall Square Bldg., Chicago, Ill. Program includes papers on a quantitative measurement of smoke, the law as applied to air pollution, hand fired heating equipment with different kinds of coal, etc.

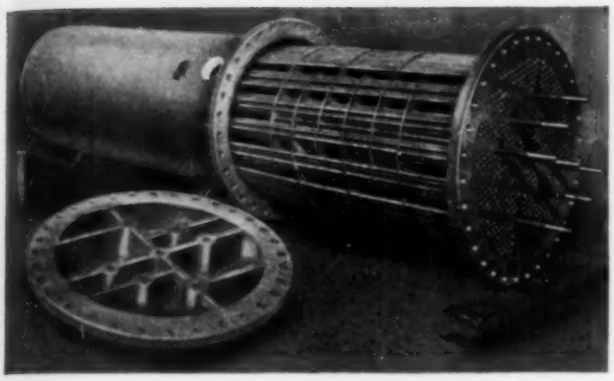
International Petroleum Exposition: May 18-25, Tulsa, Okla.

Heating, Piping and Air Conditioning Contractors National Association: Annual convention, May 27-29, Hotel Pennsylvania, New York, N. Y. Secretary, Joseph C. Fitts, 1250 Sixth Ave., New York, N. Y. Program includes report on apprentice training courses, by Wm. V. Hoier; welding committee report on standard procedure for electric arc pipe welding, by Thos. I. Magan; introduction of IBR ratings on cast iron boilers, by Harry M. Hart; sizing air conditioning compressors and application of convectors to hot water heating installations, by Geo. P. Nachman; air conditioning promotion, by J. Lawrence DeNeille; trade promotion, by Edwin P. Ambler; certification program, by W. M. Smith; and others. Wednesday morning session to be held at World's Fair as part of "heating and air conditioning day."

National Warm Air Heating and Air Conditioning Association: Mid-year meeting, June 3-5, Palmer House, Chicago, Ill. Managing director, Allen W. Williams, 5 E. Long St., Columbus, Ohio.

American Association of Industrial Physicians and Surgeons: Annual meeting, June 4-7, Hotel Pennsylvania, New York, N. Y. Executive Secretary, Armour G. Park, 540 N. Michigan Ave., Chicago, Ill. Devoted to problems of industrial health in all their phases—medical, technical and hygienic—with particular stress on prevention and control of occupational hazards.

Stoker Manufacturers Association: Annual meeting June 6-7, Homestead Hotel, Hot Springs, Va. Headquarters office, 307 N. Michigan Ave., Chicago, Ill.



Install 'em and forget 'em!

When you install Patterson Freon Coolers in your air conditioning system, *your job is finished.* You won't have any call-backs on account of Freon leakage, damage to compressors, lack of cooling, inefficient oil return, rusty tubes or any of the complaints so common.

The reliable and capable performance of Patterson Coolers, at all times and under all conditions, reflect the unusual care and enduring quality that has been built into them.

Patterson Freon Coolers measure up in every respect to the same high standard of quality that has made Patterson Hot Water Storage Heaters and other heat transfer products preeminent in their respective fields for the past 60 years.

Write now for our Freon Cooler Catalog.

The Patterson-Kelley Co., Inc.

107 Warren Street East Stroudsburg, Pa.

Patterson Freon Water Coolers

TOO OFTEN, the word "obsolete" is considered as applying to machines exclusively.

The fact is, of course, *men become obsolete too*—in their ability to secure maximum results from complex modern plant equipment, in their training to keep pace with modern methods.

Industry is fast coming to recognize that obsolete manpower is as costly as obsolete horsepower. Hence the increasing emphasis on apprentice- and employee-training programs.

The International Correspondence Schools, established in 1891, have current employee-training agreements with more than 2000 progressive business and industrial concerns, large and small.

To each of these organizations, I.C.S. (after a thorough analysis of that concern's needs) provides a "tailor-made" training program, designed to provide a permanent source of soundly trained, *modernized manpower*—familiar with that concern's methods, equipment, organization, products, customer-requirements and policies. In short, manpower with the *knowledge* and *background* to make it more efficient, productive and profitable than otherwise possible.

If you would like complete information on this important phase of I.C.S. activity, mail the attached coupon (which implies no obligation, of course).

International Correspondence Schools

SCRANTON, PENNSYLVANIA

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 9212, Scranton, Penna.

Please send full information on I.C.S. group training activities to:

Name _____ Position _____

Company _____

Address _____

WARNS WHEN AIR-FILTER CLOGS WITH DIRT

DIRT clogged filters in the air circulating system mean reduced efficiency and added power costs. On the other hand, changing filters oftener than necessary represents money wasted.

Install a Hays Air-Filter Gage and know exactly just how dirty and inefficient your filters are. An indicator shows the air resistance at all times. When the resistance becomes excessive an alarm is sounded or signal flashed. A high quality precision instrument by pioneer instrument makers. Write 990 Eighth Avenue, Michigan City, Indiana for special bulletin 37-278.

HAYS AIR-FILTER GAGE

TELLS CONDITION OF FILTER AT ALL TIMES

The HAYS CORPORATION

SINCE 1921 — COMBUSTION INSTRUMENTS AND CONTROL — MICHIGAN CITY, INDIANA, U.S.A.

New Low Cost

ALLVENT FANS

FOR ALL VENTILATING PURPOSES

- **For factory and office ventilation.**
- **For stores and public meeting places.**

A newly perfected unit that provides any normal required amount of air changes without objectionable noises. A propeller fan that delivers or exhausts large enough quantities of air to do a COMFORT-COOLING job as well.

Features Include . . . "V" BELT DRIVE that makes possible slow speed, QUIET operation; greater efficiency with 1750 RPM stock motors than heretofore obtained with costlier low speed special motors; exceptional economy of operation; unusual large volumes of air delivered at low speed; almost no service or maintenance expense.

- You cannot name a single industrial or commercial establishment or public building that is not in need of this amazing, hushed-operation type fan.

New Bulletin No. 206 carries a complete story of ALLVENT'S place in every ventilating application! Write today!

AUTOVENT FAN & BLOWER CO.

1811-27 N. Kostner Ave. Chicago, Ill.

American Society of Refrigerating Engineers: Spring meeting, June 9-11, Skytop Lodge, Skytop, Pa. Secretary, David L. Fiske, 37 W. 39th St., New York, N. Y. Program includes papers on Refrigeration in the Chemical Industry, by D. H. Killeffer; Performance of Heat Exchangers, by David Crampton; Effect of Superheat on Compressor Capacity, by R. H. Tull; Distribution of Air, by Walter Grant; and The Problem of the Air Conditioning Sales Manager, by J. deB. Shepard.

American Society of Heating and Ventilating Engineers: Semi-annual meeting, June 17-19, Wardman Park Hotel, Washington, D. C. Secretary, A. V. Hutchinson, 51 Madison Ave., New York, N. Y.

American Society of Mechanical Engineers: Annual meeting, June 17-20, Hotel Pfister, Milwaukee, Wis. Headquarters office, 29 W. 39th St., New York, N. Y. Program includes papers on Flow Through Turbines and Pumps, by J. R. Weske; Centrifugal Pump Efficiency Measurements, by R. W. Angus; Study of Heat Insulation Problems in Power Plants, by E. T. Cope; and Experience with Metals at High Temperatures, by A. E. White.

National Association of Building Owners and Managers: Annual convention, June 17-20, Commodore Hotel, New York, N. Y. Headquarters office, 134 S. La Salle St., Chicago, Ill.

American Society for Testing Materials: Annual meeting, June 24-28, Chalfonte-Haddon Hall, Atlantic City, N. J. Headquarters office, 260 S. Broad St., Philadelphia, Pa.

Eastern States Exposition: September 15-21, Springfield, Mass. For further information address J. H. Fifield, Eastern States Exposition, Springfield, Mass.

Power Show: 14th National Exposition of Power and Mechanical Engineering, December 2-7, Grand Central Palace, New York, N. Y. Under management of International Exposition Co., Grand Central Palace, New York, N. Y.

American Chemical Exposition: December 11-15, Stevens Hotel, Chicago, Ill. Under auspices of Chicago section, American Chemical Society. Exposition manager, Marcus W. Hinson, 110 N. Franklin St., Chicago, Ill.

Recent Trade Literature

For your convenience in obtaining copies of these bulletins, see coupon on page 142. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending your request to HEATING, PIPING AND AIR CONDITIONING.

No. 3501. ACOUSTICAL AND INSULATION CEMENT: Hetzel Roofing Products Co., 67 Main St., Newark, N. J. 4 p. bulletin on "Acoustiglu" elastic acoustical and insulation cement for applying soundproofing, insulation and acoustic tile on ceilings, walls, dryers, storage tanks, etc.

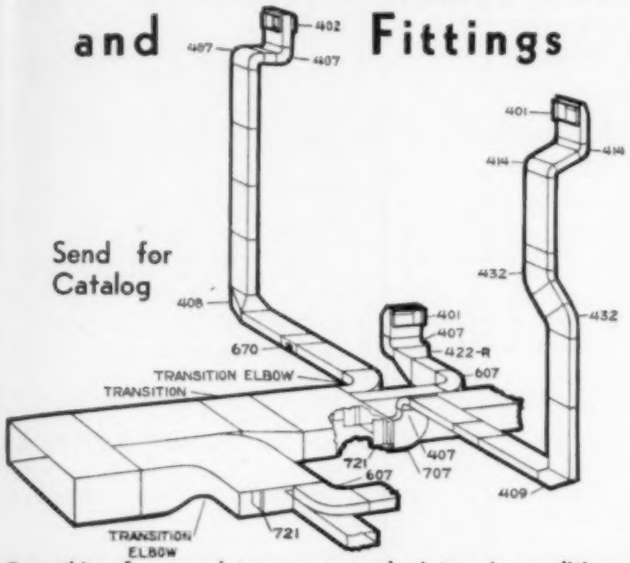
No. 3502. AIR CONDITIONING COILS: Kramer Trenton Co., 626 Brunswick Ave., Trenton, N. J. 32 p. catalog (AC540) on air conditioning coils, with information on selection, rating tables, and pertinent engineering data, covering direct expansion, steam and water coils.

No. 3503. AIR CONDITIONING UNITS: Carrier Corp., 302 S. Geddes St., Syracuse, N. Y. 6 p. bulletin announcing seven new self-contained "Weathermaker" units. Also, 4 p. bulletin on room units for offices and homes.

No. 3504. AIR CONDITIONING UNITS. Micheli Air Conditioning Co., Inc., 1725 State St., Schenectady, N. Y. 4 p. bulletin on horizontal type "Multi-Zone" air conditioning unit for stores, apartment buildings, restaurants and homes, with description of features and specifications.

MONCRIEF

Air Conditioning Pipe and Fittings



Send for Catalog

Everything for complete summer and winter air conditioning installations. Made with special Moncrief lock joints. The product of 39 years experience in the manufacture of pipe and fittings. Send for Catalog.

The Henry Furnace & Foundry Co.
3480 E. 49th St. Cleveland, Ohio

EXTREMES

A 4½" bellows capable of 1¾" movement; and a 1⅝" bellows capable of 350 lbs. pressure per square inch.

HYDRON

Metallic Bellows

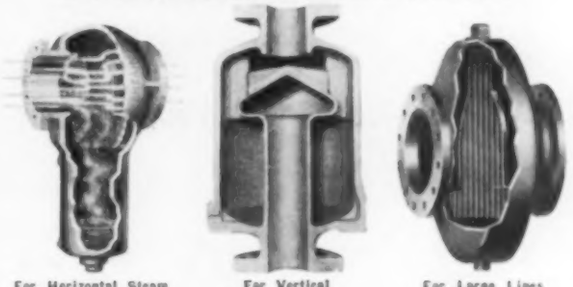
HYDRON Metallic Bellows are used as control elements in temperature-and-pressure-control devices, and for liquid or gas seals of compressors and pumps. We are specialists in the design and production of complete thermostatic and pressure units for temperature and pressure controls. We are, therefore, prepared to extend the fullest co-operation to engineering departments of control manufacturers in the solution of design and engineering problems.

Write for 44-page Engineers' Data Book.

CLIFFORD MANUFACTURING CO.
BOSTON CHICAGO DETROIT LOS ANGELES
PRODUCERS OF BELLOWS EXCLUSIVELY
SERVING AUTOMATIC CONTROL MANUFACTURERS

COCHRANE SEPARATORS

increase the efficiency of Heating Steam by removing Oil and Moisture



For Horizontal Steam or Air Lines — For Vertical Down-Flow Lines — For Large Lines at Low Pressure

Oil coats the inner surfaces of heating pipes and coils and has an insulating effect. Moisture reduces the heating efficiency of the steam. You can eliminate both oil and moisture from heating steam by installing Cochrane Steam Separators.

Cochrane Separators require no maintenance; they are self-cleaning; pressure loss is minimized and their design prevents carry-over of entrainment.

One or more Cochrane Separators in over 10,000 plants are daily demonstrating their exceptional service and economy.

Write for Publication 2950 for technical information.

COCHRANE CORPORATION
3131 N. 17th St. Philadelphia, Pa.

COCHRANE

VALVES · TRAPS · SEPARATORS · SPECIALTIES

ADSCO-BANNON CONDUIT

TILE CONDUIT FOR UNDERGROUND LINES

15" Tile Conduit with ADSCO Fiberglas Insulation recently installed by large eastern industrial plant, including ADSCO Expansion Joints.

Low in Cost – High in Thermal Conductivity

ADSCO-Bannon Tile Conduit is strong, vitrified conduit that is easily split on the job with a clean-cut fracture as illustrated above. In combination with ADSCO-Fiberglas Insulation it provides a permanent installation, high in thermal efficiency, at a reasonable cost. Send details of proposed installation for quotation or write for bulletin No. 35-67HP.

AMERICAN DISTRICT STEAM COMPANY
NORTH TONAWANDA, N.Y.
IN BUSINESS OVER SIXTY YEARS

ORIGINAL PATENTS

on developments of

AIR DEVICES CORPORATION

and

AERIET AIR CONDITIONER CO.

FOR SALE

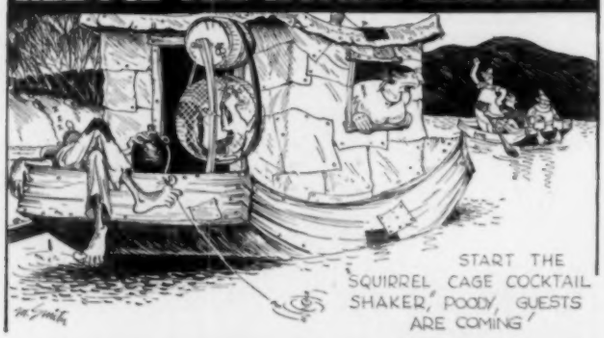
covering valuable designs of . . .

AIR CONDITIONERS
CEILING UNITS
HUMIDIFIERS
DEHUMIDIFIERS
SPACE HEATERS
HEAT TRANSFER UNITS
REFRIGERATING UNITS

This unusual opportunity is made possible by recent re-organization and discontinuation of all products in this field.

CONNECTICUT TELEPHONE & ELECTRIC CORPORATION • Meriden, Conn.

REDUCE THE HUMAN ELEMENT



WITH VICTOR MOTORS!

You can shake-'em up, stir-'em 'round and use . . . always certain that they'll never do a burn-up bog-down because of overloads. It's Victor Motors we're talking about . . . shaded-pole, induction type Victor Motors which are famous for their adaptability and long-lived ability to take it. Powerful, yes, but never drunk with it. Temperate in juice consumption. Absolute tee-totalers from trouble. Congenial in the company of choke coils or rheostats for infinite speed control. Ideal for powering any device that comes within the range of 1/200 to 1/10 HP. Special — and we mean special — oil-impregnated, self-lubricating bearings prevent Victor Motors from ever getting hot pipes. Drop us a hint on what you need in fractional horse motors. Write —
Dept. M-103

APPLICATIONS (Dizzy & Otherwise)
Animated signs, such as:
Moving a goose's neck (adv. display)
Activating funny faces (adv. display)
Turning a poll parrot (adv. display)
Moving air (any method)
Paint Shakers — Egg Beaters
Water Pumps — Drink Mixers
Timing Devices — Churns
Humidifiers — Unit Heaters — Hair Dryers
Operating Control Valves

VICTOR ELECTRIC PRODUCTS, Inc.
2950 Robertson Road . . . Cincinnati, Ohio

No. 3505. AIR DIFFUSERS: Air Devices, Inc., 17 E. 42nd St., New York, N. Y. Leaflets on new "Agitair" air diffusers available in various types, with information on features.

No. 3506. BOILERS: National Radiator Co., 221 Central Ave., Johnstown, Pa. 24 p. catalog insert giving specifications for cast iron boilers, IBR ratings, dimensional data, and other information.

No. 3507. CAST IRON FITTINGS: Central Foundry Co., 386 Fourth Ave., New York, N. Y. 56 p. catalog (36) of "Essex" steam and drainage fittings, featuring complete line of screwed fittings, flanges, flanged fittings, drainage fittings, etc.

No. 3508. CONTROLS: Automatic Control Co., 2590 University Ave., St. Paul, Minn. 8 p. bulletin (F-4) on controls and alternators for single float multiple-circuit sequence control for open tanks and sumps.

No. 3509. CONTROLS: General Controls Co., 700 W. Ivy St., Glendale, Calif. 48 p. catalog of controls, including magnetic gas and industrial valves, magnetic lever valves, thermostats, slow opening valves, relays, motor valves, low water cut-offs, boiler and fuel regulators, strainers, and package sets.

No. 3510. CONVECTOR ENCLOSURES: National Radiator Co., 221 Central Ave., Johnstown, Pa. 4 p. bulletin on new "Aero" convector enclosures, illustrating 22 different designs of standard and special de luxe enclosures.

No. 3511. COOLING TOWERS: Marley Co., 3001 Fairfax Rd., Kansas City, Kans. 24 p. bulletin (602) on industrial water cooling, concerning a new "Double-Flow" cooling tower recently developed and its several features. Also, a 32 p. bulletin (601) on induced draft cooling towers for air conditioning for industrial use, illustrating and describing features of design and construction, and showing numerous installations.

No. 3512. DEEP WELL WATER SYSTEMS: Roots-Connersville Blower Corp., 16th St. & Columbia Ave., Connersville, Ind. 2 p. bulletin (260-B15) covering "R-C Auto-Jet" line of deep well water systems in a range up to 1600 gph for air conditioning, industrial and other service.

No. 3513. ELECTRICAL APPLIANCE TESTER: Hickok Electrical Instrument Co., Dupont and Williams Sts., Cleveland, Ohio. 2 p. bulletin on new volt-ampere-wattmeter electrical appliance tester and circuit analyzer for measuring actual load values of volts, amperes and watts.

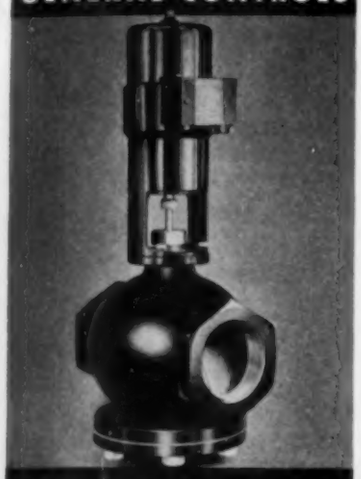
No. 3514. ELECTRICAL EQUIPMENT: Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 64 p. "Quick Selector" catalog (30-000) prepared to facilitate selection of correct apparatus for any motor, lighting or feeder circuit, and covering safety switches, "Nofuze" breakers, multibreakers, panel boards, motor control and motors.

No. 3515. ELECTRICAL HEATING UNITS: General Electric Co., 1 River Rd., Schenectady, N. Y. 4 p. bulletin (GEA-214D) on "Calrod" immersion heaters for water and oil; 4 p. bulletin (GEA-1157C) on strip heaters; 4 p. bulletin (GEA-2618A) on fin heating units for forced convection air heating; 2 p. bulletin (GEA-104B) on cartridge type heating units; 8 p. bulletin (GEA-2592A) on unit heaters of the forced and natural convection types; and 4 p. bulletin (GEA-1265D) on thermostats for use with midget heating units.

No. 3516. FANS: Emerson Electric Mfg. Co., 1847 Washington Ave., St. Louis, Mo. 16 p. bulletin (X3659) on ventilating and exhaust fans for commercial, industrial and domestic installations.

No. 3517. FANS: Victor Electric Products, Inc., 737 Reading Rd., Cincinnati, Ohio. 8 p. bulletin on "In-Bilt" ventilator fans. Also, 12 p. bulletin on circulating and exhaust fans with capacity and dimension data.

GENERAL CONTROLS



HYDRAMOTOR VALVE

A Veritable POWERHOUSE

A new two-wire hydraulically operated, full-ported, *all-purpose* motor valve for air, water, gas, gasoline, oil (any gravity and grade) brine, or saturated steam up to 150 lbs. per sq. inch, and 125° F. to 250° F.

ENTIRE OPERATOR SEALED IN OIL FOR LIFE!

NO ANNUAL MAINTENANCE

Here is one of the most versatile motor valves ever developed. Operates on simplified two-wire control. There are no gears to wear out,—only one internal switch. Amazingly low in current consumption, 60 VA during opening, 5 VA when open. Valve is full-ported and will operate in any position. 100% tight shut-off assured. Entire operator is sealed in oil for life, eliminating usual annual maintenance. Write for new 1940 Catalog containing complete engineering details and specifications.

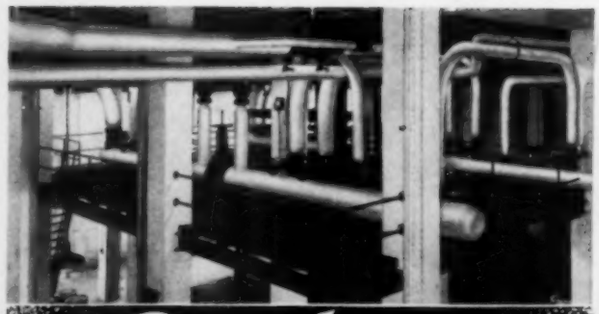
GENERAL CONTROLS
450 EAST OHIO STREET, CHICAGO, ILL. — 267 FIFTH AVENUE, NEW YORK CITY

SHAVE *and a* RUB-DOWN *for a Pipe Union*

HERE are two extra features in Darts, that you won't find in ordinary unions: Dart's two bronze seats first get *a clean shave* by precision machining to a true arc, then a *rub-down* by a special grinding process on machines of Dart's own design.

These two exclusive processes assure you *more service per dollar* by providing tightness under repeated use. Darts make up tight, come apart readily, can be used over and over. That's real economy. Send for a Dart to try, free.

DART UNIONS
E. M. DART MFG. CO., PROVIDENCE, R. I.
SALES AGENTS: THE FAIRBANKS COMPANY, NEW YORK AND ALL BRANCHES — CANADIAN FACTORY: DART UNION COMPANY LTD., TORONTO, CANADA



Carey INSULATION

CONTRIBUTES TO COMFORT AND ECONOMY in New U. S. Department of Justice Building

ONE of the largest and most beautiful of the new government buildings is that housing the Department of Justice. A 7-story structure costing more than $11,000,000, it has 1,237,000 sq. ft. of floor space. The extensive steam system, and the air-conditioning system of 1800-ton capacity, are insulated with CAREY Heat Insulation. This is but one of the notable insulation jobs completed in recent years on government buildings in the National Capital.

CAREY Insulations save fuel, conserve heat. Whatever the insulation requirements of your heating and air-conditioning jobs, CAREY Products can satisfy them. Write for CAREY Insulation Catalog — Address Dept. 25.

THE PHILIP CAREY COMPANY • Lockland, Cincinnati, Ohio
Dependable Products Since 1873
BRANCHES IN PRINCIPAL CITIES

G&O RADIATION

FINNED COILS FOR HEATING AND COOLING
AVAILABLE IN A WIDE RANGE OF SIZES

SEND FOR CATALOG

WATER COOLING COILS

THE G&O MANUFACTURING COMPANY
New Haven, Connecticut
Pioneer Manufacturers of Square Finned Tubing in the United States

"STEAM SAVED—SPEED INCREASED"

Pie Bakeries, Chicago, is a busy place. Thousands of pie plates are washed daily. Sarco TR-21 Temperature Controls, one on the wash tank, and one on the rinse tank, now keep things moving. Regardless of the load, Sarco keeps the temperatures always the same. This eliminates returns through the washer and provides a saving in steam consumption. Sarco products always save. In addition they always speed up, perfect, and stabilize any production operation. Catalog No. 52.

Sarco Temperature Regulator

43

SARCO COMPANY, INC.
183 Madison Avenue, New York, N. Y.
SARCO CANADA LTD., FEDERAL BLDG., TORONTO, ONT.

SARCO

SEE PHONE BOOK FOR LOCAL SARCO REPRESENTATIVE

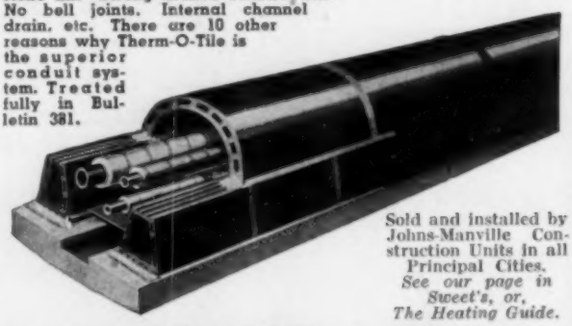
THERM-O-TILE

Reg. U. S. Pat. Off.

The Conduit for Underground Steam Lines

SIMPLEST • STRONGEST • MOST EFFICIENT

Monolithic concrete base. No broken stone fill. Strong arched construction. No bell joints. Internal channel drain, etc. There are 10 other reasons why Therm-O-Tile is the superior conduit system. Treated fully in Bulletin 381.



Sold and installed by Johns-Manville Construction Units in all Principal Cities.
See our page in Sweet's, or, The Heating Guide.

H. W. PORTER & CO., Inc.

822-H Frelinghuysen Ave., Newark, N. J.

Without obligating us in any way, ☐ Please send Bulletin 381; ☐ Send representative. ☐ Enclosed is a sketch, with principal data of a prospective job on which we shall be glad to have your comments or quotations.

Name .....

Firm .....

Street .....

City..... State.....

No. 3518. MOTORS: General Electric Co., 1 River Rd., Schenectady, N. Y. 4 p. bulletin (GEA-3345) on synchronous motors and control for part winding starting, explaining advantages; 6 p. bulletin (GEA-1412B) on vertical solid shaft induction motors; 4 p. bulletin (GEA-1368D) on vertical hollow shaft induction motors of shielded (drip-proof) construction; 2 p. bulletin (GEA-3223) on single phase vertical motors.

No. 3519. MOTORS: Victor Electric Products, Inc., 737 Reading Rd., Cincinnati, Ohio. 6 p. bulletin on shaded pole induction type motors, giving ratings and performance data and a form simplifying selection of motors for specific uses.

No. 3520. MOTORS: Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 4 p. bulletin (F-8548) on a-c and d-c fractional horsepower motors in sizes from 1/20 to ¾ hp.

No. 3521. NICKEL ALLOYS: International Nickel Co., Inc., 67 Wall St., New York, N. Y. 16 p. booklet entitled "7 Minutes with 7 Metals," a general guide to the uses and properties of nickel and high nickel alloys.

No. 3522. RADIANT HEATING: A. M. Byers Co., Clark Bldg., Pittsburgh, Pa. 24 p. technical bulletin on wrought iron for radiant heating installations, including information on the theory of radiant heating, calculation principles for the design of such installations, measurement of radiant heating, selection of pipe for installations, modern radiant heating installations, and cost of radiant heating. Much pertinent technical data are presented.

No. 3523. REGISTERS: Auer Register Co., 3608 Payne Ave., Cleveland, Ohio. 64 p. register book (40) including information and illustrations on a complete line of air conditioning registers for wall and baseboard installation, floor grilles, floor registers, air conditioning grilles, louvers, and accessory equipment, and including list prices, information on air distribution, and other data.

No. 3524. REGISTERS: Independent Register Co., 3747 E. 93rd St., Cleveland, Ohio. 2 p. bulletin (403) on wrought steel air conditioning registers with flexible grille bars.

No. 3525. STOKERS: Detroit Stoker Co., General Motors Bldg., Detroit, Mich. 24 p. bulletin (600) describing the "Uni-Stoker" with descriptions in text and pictures of its features, diagrams of its application to various types of boilers, and information on numerous installations and its manufacture.

No. 3526. TRAPS: Wright-Austin Co., 315 W. Woodbridge St., Detroit, Mich. 2 p. data sheet on traps for draining compressed air lines, giving information on advantages, list prices, weight, capacities and dimensions.

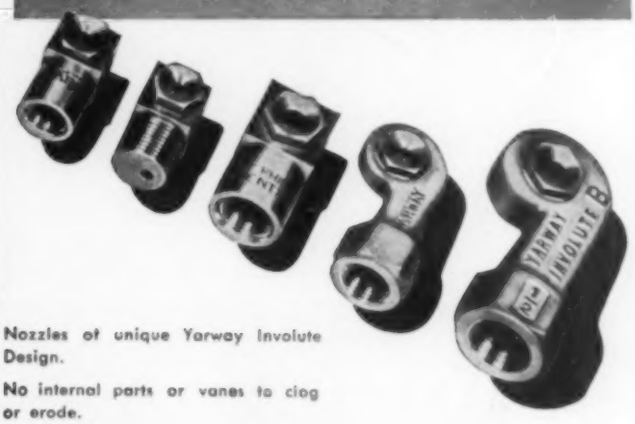
No. 3527. UNDERGROUND STEAM CONDUIT: RicwiL Co., 1562 Union Trust Bldg., Cleveland, Ohio. 24 p. catalog (40) on conduit systems for underground steam lines and outside overhead piping, containing cut-away illustrations, cross-section details and specifications of a wide variety in types of design, insulation and materials for underground steam construction. Information on accessory equipment is also included as is engineering data on pipe sizes, heat loss, anti-water protection, insulation efficiency and other items.

No. 3528. VALVES: Hancock Valve Div., Manning, Maxwell & Moore, Inc., 11 Elias St., Bridgeport, Conn. 40 p. bulletin (5-7000) on steel valves containing complete dimensions of various types, material specifications of metals used in the valves and reproducing the ASME service rating tables. Information is also given on "Duravalve" and "bar stock" valves.

No. 3529. VALVES: Henry Valve Co., 1019 N. Spaulding Ave., Chicago, Ill. 2 p. bulletin and price list (128) on balanced action diaphragm packless valves, which incorporate a number of new features.

1 SEAMLESS
2 UNIFORMLY FULL PIPE THICKNESS
3 SELECTIVE, UNIFORM REINFORCEMENT
4 TANGENTS
5 MACHINE TOOL BEVELLED
6 ENDS MARKED IN QUARTERS
7 COMPLETE IDENTIFYING MARKS ON EVERY FITTING
8 A FULL LINE
If it hasn't these 8 features it isn't a TAYLOR FORGE WeldELL
TAYLOR FORGE & PIPE WORKS
General Offices and Works: Chicago, P. O. Box 485
New York Office: 50 Church Street

AIR CONDITIONING NOZZLES



Nozzles of unique Yarway Involute Design.

No internal parts or vanes to clog or erode.

Insure trouble-free air washing service.

Sizes and types for all requirements.

Many large users—installations total more than 5 million gallons per minute in water cooling and air conditioning service. Write for Bulletin N-615.

YARNALL-WARING COMPANY
107 MERMAID AVENUE
PHILADELPHIA

YARWAY

M&E EST. 1866

One of America's Most Complete and Adaptable Lines!

REFRIGERATION COMPRESSORS

FOR AIR CONDITIONING
and every commercial use

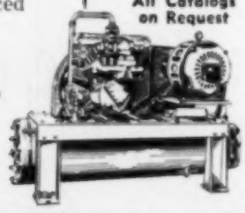
● Contractors and engineers are invited to familiarize themselves with this quality line which is now on its 15th successful year. Inquiries are also invited from responsible selling agents in territories not now represented. Full protection is available plus association with an old, responsible and experienced manufacturer. Address:

MERCHANT & EVANS CO.
MAIN OFFICES:
PHILADELPHIA, PA.
Plant: LANCASTER, PA.

1/5 to 25 HP
and up to 30 HP in MULTIPLE UNITS

ALL FRACTIONAL SIZES
and a new line of "PACKAGE UNITS"
1/5, ¼, 1/3 HP for Self-contained applications requiring small, low, compact mounting dimensions.

A.S.R.E.—NEMA RATINGS
Underwriters Label
All Catalogs on Request



This book is FREE

A complete, pocket-size manual of machinery isolation. 38 pages, fully illustrated.

THE VIBRATION ELIMINATOR CO.
2508, 37TH AVE., L. I. CITY, N. Y.

NAME .....
FIRM .....
ADDRESS .....
CITY ..... STATE .....
TYPE OF COMPRESSOR .....

FOR YOUR CONVENIENCE

HEATING, PIPING AND AIR CONDITIONING,
6 N. Michigan Ave., Chicago, Ill. [5-40]

Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in "Equipment Developments" and "Recent Trade Literature." (Circle numbers in which you are interested):

1833	1834	1835	1836	1837	1838	1839	1840	1841	1842
1843	1844	1845	1846	1847	1848	1849	1850	1851	1852
1853	1854	1855	1856	1857	1858	1859	1860	1861	1862
1863	1864	1865	1866	1867	1868				
3501	3502	3503	3504	3505	3506	3507	3508	3509	3510
3511	3512	3513	3514	3515	3516	3517	3518	3519	3520
3521	3522	3523	3524	3525	3526	3527	3528	3529	3530
3531	3532								

Name ..... Title.....

Company .....

Address .....

City ..... State .....

No. 3530. V-BELT DRIVES: L. H. Gilmer Co., 7230 Keystone St., Tacony, Philadelphia, Pa. 96 p. booklet on v-belt practice, including new horsepower ratings for multiple belts, a section of sheave information, including data on flat pulleys for v-to-flat drives, and adjustable diameter and companion sheaves. In addition to extensive listings of standard sheave combinations for complete drives, there is an engineering section for designing special drives with formulas, description of special use v-belts and handy tables for engineers.

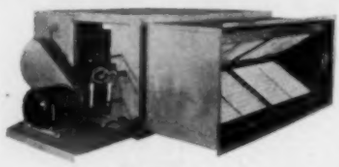
No. 3531. WELD SPATTER: General Electric Co., 1 River Rd., Schenectady, N. Y. 2 p. bulletin (GEA-3198A) on "Glyptal" for preventing adhesion of weld spatter.

No. 3532. X-RAY INSPECTION: St. John X-Ray Service, Inc., 30-20 Thomson Ave., Long Island City, N. Y. 4 p. leaflet devoted to x-ray and radium inspection and listing the 92 elements and other data pertaining to x-ray work.

Marlo Coil Co.

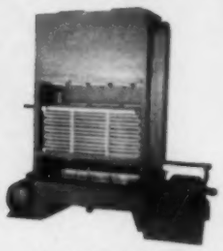
6135 MANCHESTER AVE.,
ST. LOUIS, MO.

Air Conditioning Coils—Blast Coils
Extended surface coils for all refrigerants. Made of any of the common metals. Blast coils for steam, water, or brine. Complete details in Bulletin No. 396.



Air Conditioning Units
Air Conditioning Units in either ceiling suspended or floor type. Capacities from 900 cu. ft. to 12,000 cu. ft. Sturdily built on welded angle iron frames of sectional design for easy installation. Bulletin No. 409 gives complete details.

Refrigeration Equipment Manufacturers



Evaporative Condenser
Self-contained; single motor drive for fans and pump; all prime surface coils; electric welded frame galvanized after fabrication; internal surface covered with corrosion resistant mastic. Full details in Bulletin No. 404. Y—5R1

Any range 15 F.P.M. to 24,000 F.P.M.

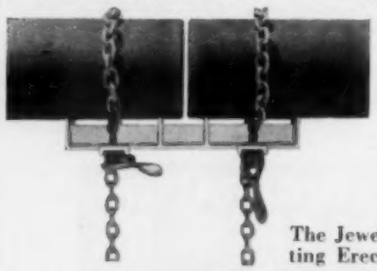
TAKES JUST A MOMENT TO CHECK AIR VELOCITIES WITH THE

Alnor ALL PURPOSE VELOMETER

You can save time and know whether your heating and air conditioning jobs are right when you use the "ALNOR" Velometer. Without timing or complicated mathematical calculations the Velometer gives direct, accurate, instantaneous air velocity readings. Many users report that with the Velometer they can check and balance a system in one tenth the time formerly required, and the Velometer gives them a picture of air distribution that no other instrument can. Write for details.

ILLINOIS TESTING LABORATORIES, INC.
419 N. La Salle Street Chicago, Illinois

PIPE WELDING TOOLS THAT MAKE WELDING PAY



Pipe Clamps
Flange Clamps
Elbow Clamps
Angle Clamps
Pipe Markers

TWO SIZES
½ to 8 in. 8 to 16 in.
Light—Adjustable—Fast

The Jewel System of Pipe and Fitting Erection Ready for the Weld

Keeps the Welder Welding Instead of Waiting
CUTS ERECTION COSTS
Modernize Your Own Methods and Tool Equipment

JEWEL MANUFACTURING COMPANY
1874 Highland Pkwy., St. Paul, Minn.

PERMANENT · EFFICIENT · ECONOMICAL

PALCO INSULATION
TRADE MARK REG. U. S. PAT. OFF.
WOOL

The Pacific Lumber Company
100 Bush St., San Francisco

SHELL and TUBE
CONDENSERS
LIQUID RECEIVERS
SURGE TANKS

ACME INDUSTRIES
JACKSON MICHIGAN